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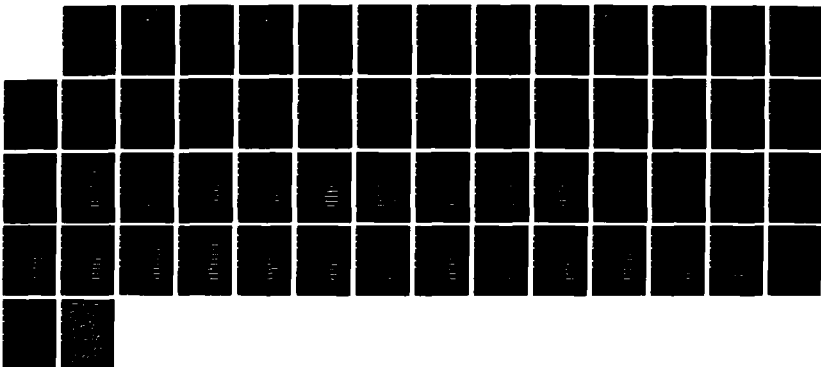
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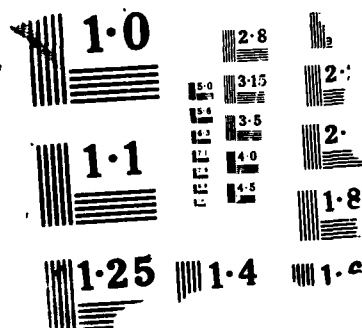
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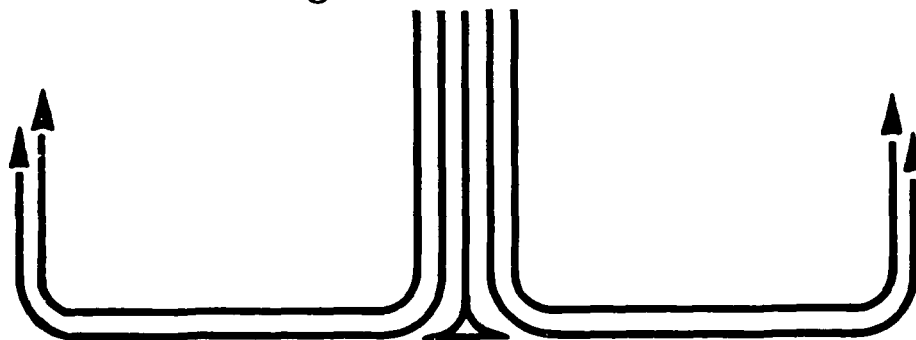
AIR COMMAND AND STAFF COLLEGE

STUDENT REPORT

LOW CEILINGS AND POOR VISIBILITY
CAN EFFECT LOW ALTITUDE AIR TO AIR
REFUELING IN EUROPE

MAJOR WILLIAM H. FISCHER 88-0900

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REPORT NUMBER 88-0900

TITLE LOW CEILINGS AND POOR VISIBILITY CAN EFFECT LOW ALTITUDE
AIR TO AIR REFUELING IN EUROPE

AUTHOR(S) MAJOR WILLIAM H. FISCHER, USAF

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Submitted to the faculty in partial fulfillment of
requirements for graduation.

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PREFACE

This paper was written to assess the feasibility of low altitude air to air refueling (LAAAR) training in the NATO or European area of operations. The growing Warsaw Pact threat to our air refueling operations has made LAAAR an important means to tanker survivability. There has been some limited research or testing on LAAAR. The aircraft structural capability to withstand numerous low altitude sorties has been questioned. Additionally, the systems capability and navigational procedures used for LAAAR have been examined. The author has attempted to relate these issues to the need for weather planning and training considerations before implementing LAAAR in the European theater. The author has extensive KC-135 experience, both operational and planning, in the European area. Therefore, the information in the report is based partly on his knowledge.



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—ABOUT THE AUTHOR—

Major William H. Fischer is a senior navigator with over 2000 hours in the KC-135 aircraft. He received his commission through Officer Training School in 1974. Following Undergraduate Navigator Training, he was assigned as a KC-135 navigator in the 91st Air Refueling Squadron at McConnell AFB, Kansas. From 1978 to 1982 he was assigned to the 909th Air Refueling Squadron at Kadena AB, Okinawa, where he served as instructor navigator and flight examiner. In 1982 he was assigned to the 34th Strategic Squadron, Zaragoza AB, Spain, where he was an air operations officer and staff navigator. In 1984 he was assigned to Seventh Air Division (SAC) Ramstein AB, Germany as the Chief, Tanker Operation Branch and later Deputy Chief, Tanker Division. He has extensive experience in scheduling, planning, executing and flying air refueling missions throughout the European theater of operations. Major Fischer holds a Bachelor of Business Administration degree in Finance from the University of Texas and a Master of Arts degree in Management from Webster College. Major Fischer is married to the former Sonya Lynn Manley and has one daughter, Shana.

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REPORT NUMBER 88-0900

AUTHOR(S) MAJOR WILLIAM H. FISCHER, USAF

TITLE LOW CEILINGS AND POOR VISIBILITY CAN EFFECT LOW
ALTITUDE AIR TO AIR REFUELING IN EUROPE

I. **Purpose:** To determine the feasibility of conducting low altitude air to air refueling (LAAAR) training in the European area of operations. With primary emphasis on the impact of low ceilings and poor visibility prevalent in Europe.

II. **Problem:** Some receiver commands and the Commander in Chief of the Strategic Air Command have stated the need for LAAAR training. The European Tanker Task Force has not been training in LAAAR. One of the main obstacles to LAAAR training in theater was the concern over lost training when the weather prevented it.

III. **Data:** An ACSC research project on low level refueling by Majors Krull and Siegel, evaluations by CFIC and the Phoenix ANG unit, and training programs by both the 305th Air Refueling Wing and the 376th Strategic Wing were all examined. Visibility and ceiling data, obtained from the USAF Environmental Technical Applications Center publication "Station Climatic Summaries, Europe," was correlated to selected air refueling tracks and anchors in Germany, England and Scotland to determine the time of day and month when weather would permit LAAAR training. This data was graphed in bar chart form to enable more rapid assessment of, if and when, LAAAR training can be scheduled.

CONTINUED

IV. Findings: All of the reports indicate that LAAAR is possible, however, there are certain limitations. The KC-135 requires certain structural modifications prior to full scale LAAAR training. Additionally, control of the aircraft is not significantly different at low altitude and the navigation equipment, when used with visual backup, is acceptable. Also, the aircrew can become task saturated, if additional training in LAAAR procedures is not practiced periodically. Finally, the low ceiling and visibility will prevent LAAAR training if the scheduler does not take into account the information available in the graphical data. However, depending on which track and what time of day or year it is, by referring to the statistical data it is possible to select a location that has a high probability of good weather.

V. Recommendations: The European Tanker Task Force (ETTF) should begin selective training in LAAAR procedures. Also, the ETTF should graph the data on the tracks and anchors they intend to use as well as secure agreements with the host nations to use certain areas for LAAAR on a routine basis.

Chapter One

INTRODUCTION

Air to air refueling (AAR) "extends the range, station time, mobility, and flexibility of theater forces" (3:3-6). Presently AAR makes a significant contribution to strategy development and success. One of the considerations when planning AAR is the vulnerability to enemy action of the air refueling aircraft as well as its receiver during refueling operations. A way to lessen this vulnerability is by refueling at low altitude, thus staying below enemy radar. If air to air refueling could be broadened to include low altitude air to air refueling (LAAAR), then AAR's critical support role would be further enhanced. General Chain, the Commander-in-Chief of the Strategic Air Command (CINCSAC) has said, "I want to be able to refuel low because that gives me one more arrow in my quiver" (1:--). Many considerations have been addressed in previous analyses of LAAAR: aircraft structural capability, system suitability, safety, crew capability, and training requirements. This paper focuses on answering the following question: Do weather conditions in Europe impact SAC's ability to conduct low altitude air to air refueling training in NATO?

LIMITATIONS AND ASSUMPTIONS

1. The KC-135 is the primary air refueling aircraft in the USAF inventory; therefore, all information, related studies, and data will be based on using the KC-135 for LAAAR.
2. The primary geographical area of emphasis will be the Federal Republic of Germany and the United Kingdom. Additionally, the existing air to air refueling (AAR) tracks and anchors in these areas could be used as LAAAR training areas without further negotiations or agreements from host nations.
3. There is no historical data on cloud coverage in air refueling tracks. The most suitable data available is on low ceiling and visibility at air fields (10:--). Therefore, weather for selected air bases or air fields nearest the existing AAR tracks is similar to weather in the tracks themselves.
4. The availability of flying hours is limited. Additional hours, specifically for LAAAR training, would not be available.

DEFINITION OF TERMS

1. Low altitude air to air refueling is between 3000 and 5000 feet above ground level (AGL). This is based on HQ SAC's policy, "Air refueling base altitude may be no lower than 3000 feet AGL" (7:3).
2. Minimum weather required for LAAAR: remain clear of clouds and have at least three miles visibility. This is based on HQ SAC policy and USAF definition of visual flight rules (VFR) (4:23; 6:--).

OVERVIEW

The following chapters represent the research project as the limitations and assumptions have refined it. Chapter Two, "Related Studies," is a review of related evaluations, projects, or assessments that have been conducted over the last few years. They have looked at aircraft capability; both structurally and systems, crew capability and training, and safety. Chapter Three, "European Analysis," is a detailed look at factors impacting LAAAR training in Europe; low clouds and limited visibility. Lastly, Chapter Four, "Summary, Conclusions and Recommendations," provides a summation and conclusions and then makes recommendations to planners striving to meet the challenges of LAAAR in Europe.

Chapter Two

RELATED STUDIES

Although the concept of LAAAR has been around for many years, there has been a very limited amount of study on the subject. The most definitive study has been KC-135A Low Level In-Flight Refueling Operations by Majors Krull and Siegel (13:--). The heart of this study revolved around a computer-simulated test using a Boeing program to assess the feasibility of KC-135 LAAAR. It also examined fuel, autopilot, and some training considerations (13:41-42). Majors Krull and Siegel concluded that "the concept of KC-135A low level refueling is a viable option for planners . . ." (13:43). However, they went on to say, " . . .the KC-135 has a limited low level capability due to air frame modification requirements and system limitations" (13:43).

The 305th Air Refueling Wing at Grissom AFB, Indiana, the Phoenix Air National Guard (ANG) KC-135 unit at Phoenix Sky Harbor International Airport, the 376th Strategic Wing (SW) at Kadena AB, Okinawa, and SAC's Central Flight Instructor Course (CFIC) at Castle AFB, California, have either incorporated LAAAR in their respective training plans or accomplished specific evaluations of LAAAR. All of the units determined that the systems, currently available, provide adequate control. They also determined that some form of visual sighting is necessary to ensure safe navigation (5:--; 7:--; 11:4; 12:2). Personnel from Phoenix ANG, the 376th SW, and CFIC have all stated the aircraft responds well to control and throttle inputs at low altitude (5:--; 7:--; 12:2). The Phoenix ANG unit evaluation determined, "Navigation consisted of 95% map reading with inertial navigation system/doppler navigation system (INS/DNS) used to verify position" (5:--). They further stated that the "Use of radar or other nav aids is impractical" (5). While the CFIC assessment was, "Proper radar interpretation is critical at low altitudes. Radar needs to be adjusted to maximize returns . . .visual navigation using ground references provided an effective way to back up other methods" (7:1). Personnel from the 305th AREFW used a combination of visual references from the pilots and radar scope interpretation from the navigator (11:4).

Both the Phoenix ANG unit and the 305th AREFW, independently determined that extra training was required to establish and maintain proficiency and counter the inherent risks associated with LAAAR (5:--; 9:3). The Phoenix ANG unit report stated, "The

average crew member would be task saturated in this environment (LAAAR) without additional training" (5:--). The 305th AREFW requires a safety observer on all LAAAR flights and requires their tactically certified crews practice two LAAARs per six-month period (9:3).

Each of these studies was conducted in the United States or the Far East under near ideal flying conditions. They all point out that LAAAR is possible with the existing aircraft and equipment. Additionally, they indicate LAAAR crews require special training. Finally, initial investigation of training reveals the need for either visual/radar or visual/INS navigation procedures. The procedures using primarily visual references worked well. However, when General Chain referred to the " . . . arrow in my quiver," he was talking primarily about the Warsaw Pact territory (NATO) or the Middle East and Persian Gulf areas (1:--). Thus, can we train in the NATO environment for LAAAR?

Chapter Three

EUROPEAN ANALYSIS

The first two chapters examined some of the factors related to LAAAR training. Limitations, assumptions, and definitions were also explained. With these in mind, the following chapter focuses on two primary climatological factors that will affect LAAAR training in Europe; low clouds and limited visibility. Air to air refueling is not anymore inherently dangerous than any other type of military flying. Low altitude air to air refueling requires more attention but as General Chain has said, "It is not unsafe at all. We're not doing anything unsafe. That would be stupid" (1:--). However, as the previous studies on LAAAR have indicated the crews can become task saturated and a safety observer (extra eyes) is necessary to avoid an accident. The studies have also pointed out the need for proficiency training in LAAAR. The low altitude environment requires more precisely honed flying and navigation skills than AAR. Therefore, if the US Air Force feels there is a need for LAAAR, then the crews that fly the KC-135 should be trained for the task. To ensure a high degree of confidence in mission success, they should train for the geographical areas where they would fly in wartime.

The European area of operations is one region where KC-135 crews could logically expect to fly. The European Tanker Task Force (ETTF) has command and control of approximately 25 KC-135s throughout the year. These aircraft and crews rotate for temporary duty (TDY) from their home stations in the United States. Over the past few years individual tanker crews from all the different SAC bases have deployed to the ETTF for anywhere from 30 to 60 days. While TDY they fly from RAF Mildenhall, RAF Fairford, both in the UK, or Zaragoza AB, Spain. The tanker crews train United States Air Forces Europe (USAFE) receiver aircrews as well as many other US and Allied aircrews in the European theater.

The AAR is conducted, primarily, in ten refueling tracks and anchor areas in England/Scotland and nine in West Germany. Most of the USAFE receiver units are also in England and West Germany. While the deployed KC-135 crews provide training for USAFE receivers, they also receive valuable training in ETTF AAR procedures. However, they currently do not train in LAAAR. A combination of rolling terrain and poor weather conditions combine to make LAAAR very hazardous and risky training proposition in Europe. The rest of this chapter examines one of

the most predominant weather characteristics of Europe; poor visibility caused by low clouds, and its effects on possible LAAAR training in Europe.

DATA COLLECTION

To accomplish the analysis of the weather, it was necessary to select air bases near existing air refueling tracks and anchor areas. The available low cloud or limited visibility data was restricted to observations conducted at air bases or airports. The data consists of periodic observations throughout each day indicating percentage of time the ceiling is less than 3000 feet and/or visibility is less than three miles. Either of these conditions preclude peacetime LAAAR because of SAC's restrictions and safety considerations (6:--).

Three air bases were selected in Germany: Ramstein, Rhein Main, and Hahn; two in England: Fairford and Bentwaters; and two in Scotland: Lossiemouth and Prestwick. The air refueling tracks near the German bases are Erika and Sandy (Figure 1). The air refueling anchors near the English bases are ARA 7 and ARA 6, while the anchor near the Scottish fields is ARA 1 (Figure 2).

(2:8-1 - 8-8) A detailed explanation of how to read the graphical data immediately precedes the graphs in the appendix. To discuss every time block for every month and each base would become monotonous. Therefore, 0700 (an early morning launch) and 1900 (night AAR certain times of the year) were selected. The percentage of time the weather is below this paper's established LAAAR minimums for the German bases will be described and then the English and Scottish bases will be briefly looked at. The weather observation data was extracted from the "Station Climate Summaries Europe" (10:--).

GERMAN REFUELING TRACKS

Ramstein, as shown in Figure 1, is located between both Erika and Sandy anchors. During the morning, 68% of the days in January, the ceiling is less than 3000 feet while the evening it is 55%. In July the morning percentage is 23% and the evening is 5%. The remaining months fall between these two extremes. (See Appendix pages 15-18)

Rhein Main is near Erika anchor and like Ramstein the peak month is January with 66% in the morning and 50% in the evening. July is also the low month with 16% in the morning and 5% in the evening. Again, the remainder of the months fall between these two.

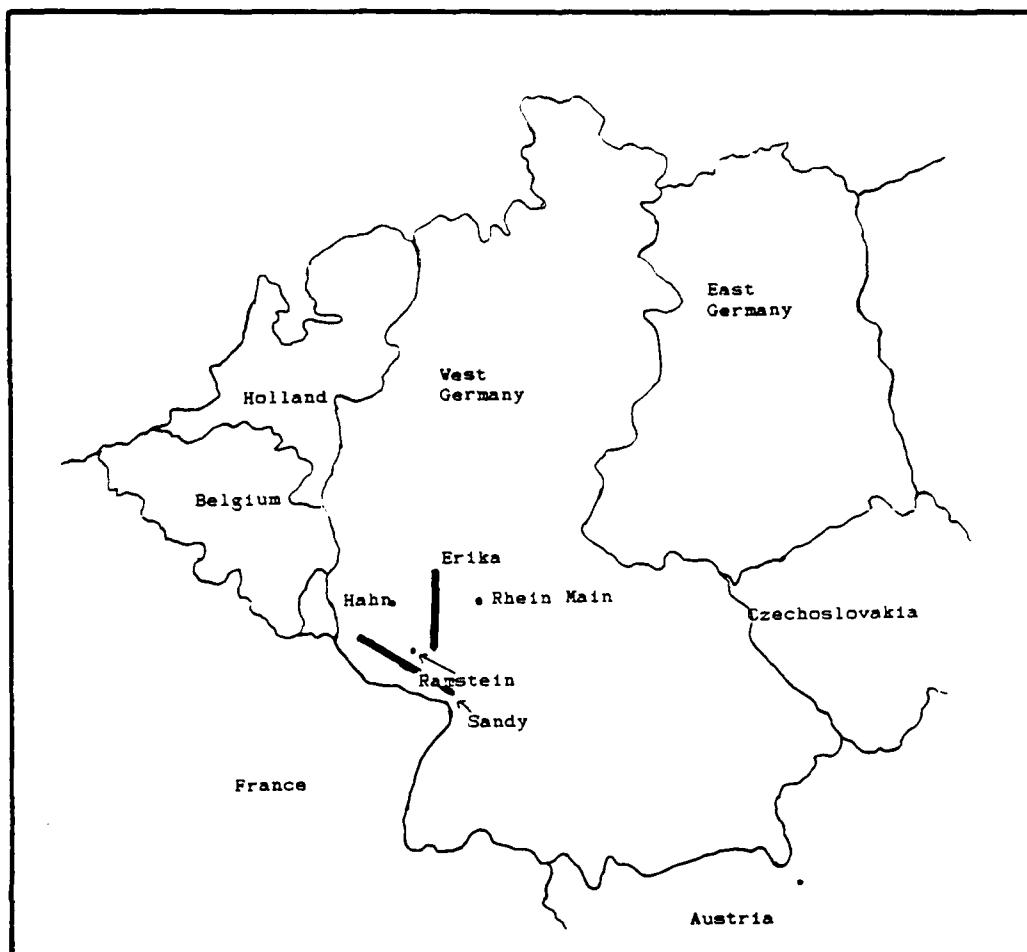


Figure 1
Source: Flight Information Publication

Hahn is located near Sandy anchor. January is high but December is the worst for both morning and evening with 81% and 73% respectively. August is the lowest at 37% and 9%.

What do all these figures really mean? If the weather in the air refueling anchors is similar to the bases near them an aircrew could expect to find low ceilings and restricted visibility in Sandy at 0700 in January from between 68-81% of the time. This high percentage would mean a considerable number of lost LAAARs. Conversely, in the evening during July or August only 5-9% of the time would the weather be restrictive for LAAAR. This does not mean that the only time LAAAR would be possible in Germany is in July or August. It does mean that careful consideration on when LAAAR scheduling should take place

must revolve around the weather history if lost air refuelings are an important factor.

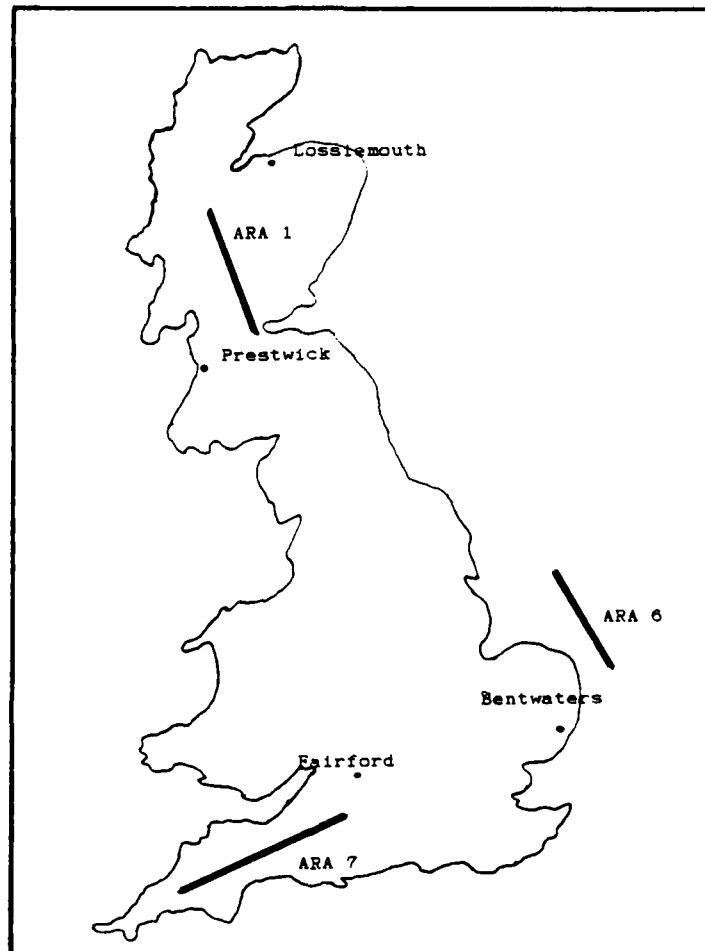


Figure 2

Source: Flight Information Publication

ENGLISH AND SCOTTISH REFUELING TRACKS

The location of the English and Scottish bases is shown in Figure 2. The same detailed analysis is possible for all four of these bases. The specific time and months when the weather is either good or bad for LAAAR is the only detail that is different. A quick look at some of the numbers indicates a loss rate of up to 60% of the time between December and January during

the evening in ARA 7. While attempting LAAAR in ARA 1 during the evening an aircrew would expect only a 14-20% loss rate.

ALTERNATIVES

Before reaching a final conclusion on LAAAR training in NATO's environment, it is necessary to decide to what degree losing air refueling training because of weather conditions is acceptable. The assumptions state that flying hours are limited. With this in mind, one can assume the Strategic Air Command cannot afford to schedule and launch KC-135 aircraft for LAAAR missions when the weather is below minimums 68-81% of the time. The obvious answer is to plan a back-up mission where the aircrew could fly a navigation training leg, pilot training sortie in the traffic pattern or a normal high altitude air refueling. For units in the United States, this is reasonable. They have flying hours allocated for all of these types of training. However, in the ETTF, flying hours are primarily allocated for air refueling activity only, with a very small percentage for staff training. Therefore, the ETTF cannot use its allocated flying hours for non air refueling sorties, such as navigation legs and pilot training, without soon running short of flying time.

The dual scheduling of a low AAR and a high AAR for the same mission presents another problem. The air refueling tracks and anchors are not owned or controlled by the USAF and are also used by our allies. There would be certain times when dual scheduling, low/high AAR, would provide the solution to bad weather in the low track. However, because so many different users compete for the air space it would not always be possible to utilize this scheduling technique.

Another alternative to resolve the problem of poor weather and its impact on LAAAR would be to determine when to schedule the activity. To accomplish this, it is first necessary to determine at what point or percentage of expected bad weather you draw the line. In other words, if the weather graph shows X% of the time in March the weather is below acceptable minimums, do you schedule a LAAAR mission or a regular high AAR?

It is possible, by examining the graphs of weather data, to determine what time of day or month to schedule a LAAAR mission for a specific anchor or track. Before doing this it is necessary to make a decision on the cut off point for acceptable losses. For the cut off point in this paper 20% was selected. This represents an acceptable chance for success in the author's opinion. If the graph indicates above 20% for the time of day desired or month for that track, then a LAAAR mission should not be scheduled. Conversely, if it is less than 20%, it is reasonable to expect successful LAAAR training.

Chapter Four

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

SUMMARY

Numerous air refueling units in the United States and one in the Far East practiced or evaluated low altitude air to air refueling. Additionally, at least one research study examined LAAAR. These reviews of LAAAR have clarified certain issues pertinent to KC-135 accomplishment of LAAAR. First, before SAC-wide, daily, LAAAR training is instituted the airframe needs to be modified. Second, the aircraft systems can support LAAAR. Even though there is a difference of opinion on how best to use the navigation equipment, it is adequate when used in conjunction with visual references. Third, and perhaps the least surprising, the aircrews need additional training, as well as recurring training, to safely conduct LAAAR. Therefore, to draw a conclusion on training for LAAAR in NATO it was necessary to look closely at the weather one could expect in Germany and the United Kingdom. Low clouds and poor visibility are significant limiting factors when considering LAAAR in Europe.

CONCLUSIONS

Looking at the country graphs (pages 43-45) in the appendix it is possible to draw some general conclusions about when to schedule LAAAR in NATO:

1. In Germany, April through September seems to be the only time, with September questionable.
2. England poses a more difficult problem. May through July are the only months that may prove acceptable.
3. Scotland has no combined monthly average less than 20%.
4. It is beneficial to refer to the individual location graphs (pages 15-42) and make selections based on time of day to schedule LAAAR.
5. With weather information to help a planner decide when to schedule LAAAR missions, it is possible to conduct limited low altitude air to air refueling training missions in Germany and the United Kingdom.

RECOMMENDATIONS

The conclusions drawn by this study support the following recommendations:

1. A test program, involving the scheduling of in-theater LAAAR training, be conducted by the European Tanker Task Force.
2. Compile and graph accurate weather data for all air refueling tracks and anchors in Europe.
3. Additional low altitude refueling tracks and anchors should be developed for routine use.

It is feasible, and perhaps more importantly, it is beneficial to train for LAAAR in NATO. As General Chain has said, "I want to be able to refuel low because that gives me one more arrow in my quiver." This arrow needs to be marked **Warsaw Pact!**

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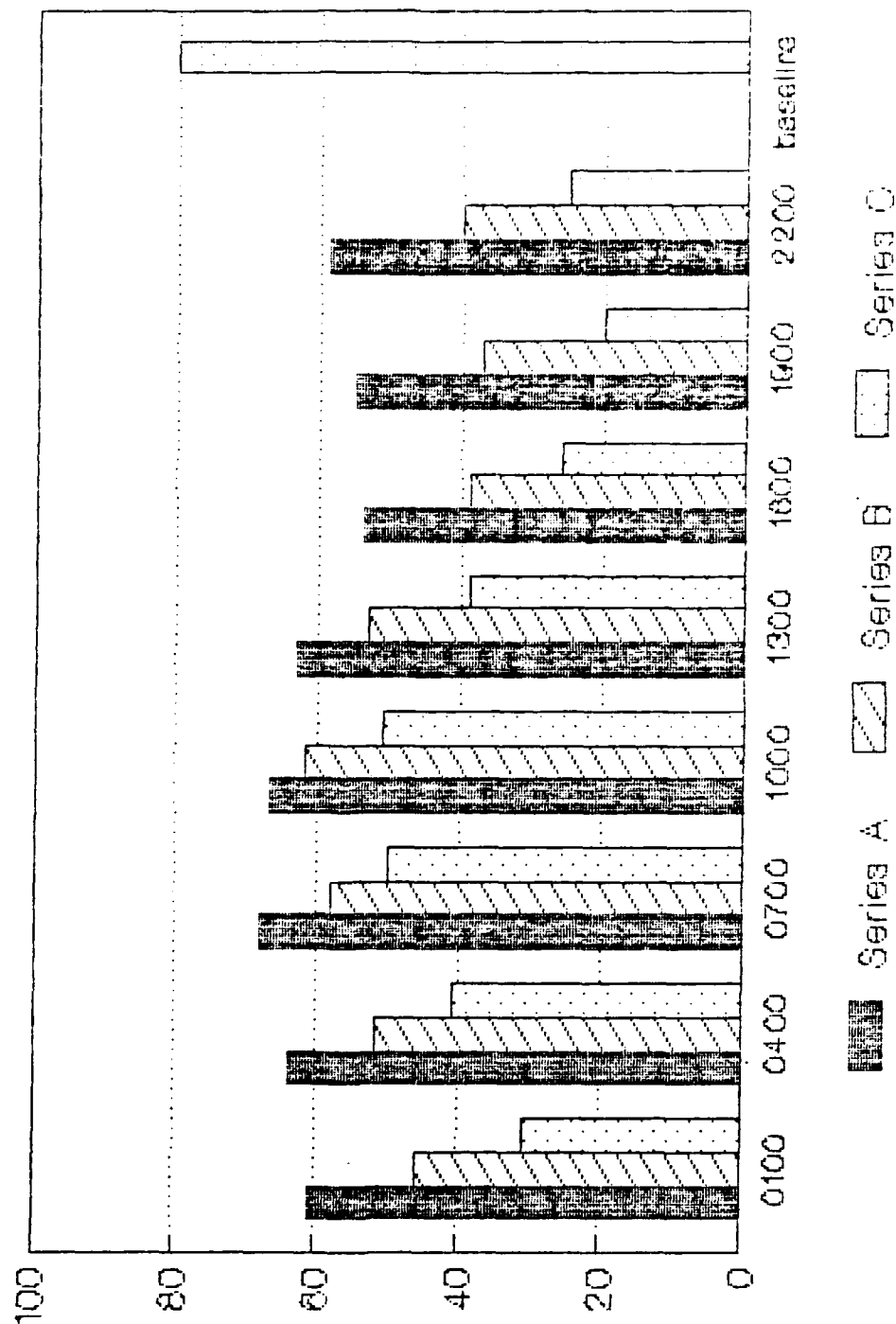
APPENDICES

The following graphs represent data extracted from "Station Climatic Summaries, Europe" (10:128,180,183,368,384,395-396, 410-411). They provide a pictorial representation of hourly observations of ceiling and visibility at the indicated air bases or fields. Using the first graph, Ramstein (Jan/Feb/Mar), as an example; the 0100 bars (series a, b, and c; January, February, and March respectively) indicate the percentage of days when the observations taken at 0100 hours, during the given month, from 1974 to 1984 where the ceiling was less than 3000 feet and/or the visibility was less than 3 miles. The baseline is a computer generated figure to make all the graphs display 0 to 100%. The time frame the hourly observations were made are as follows:

LOCATION	YEARS
Ramstein	Jan 74 - Dec 83
Rhein Main	Jan 67 - Dec 76
Hahn	Jan 73 - Dec 81
Fairford	Jun 52 - Jan 63
Bentwaters	Sep 73 - Aug 83
Lossiemouth	Jan 73 - Dec 83
Prestwick	Jan 73 - Jul 83

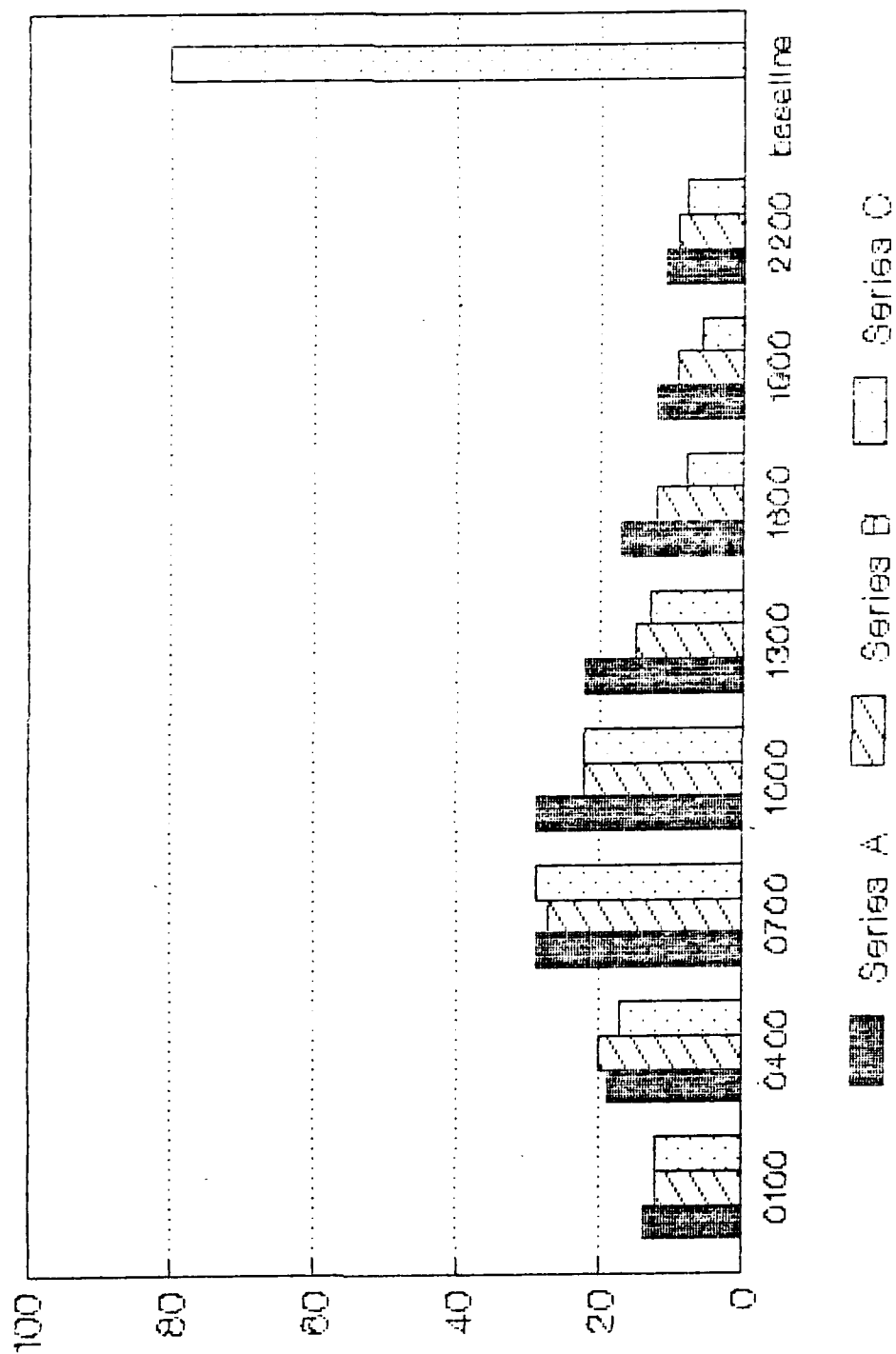
Ramstein AB, GE

Jan/Feb/Mar



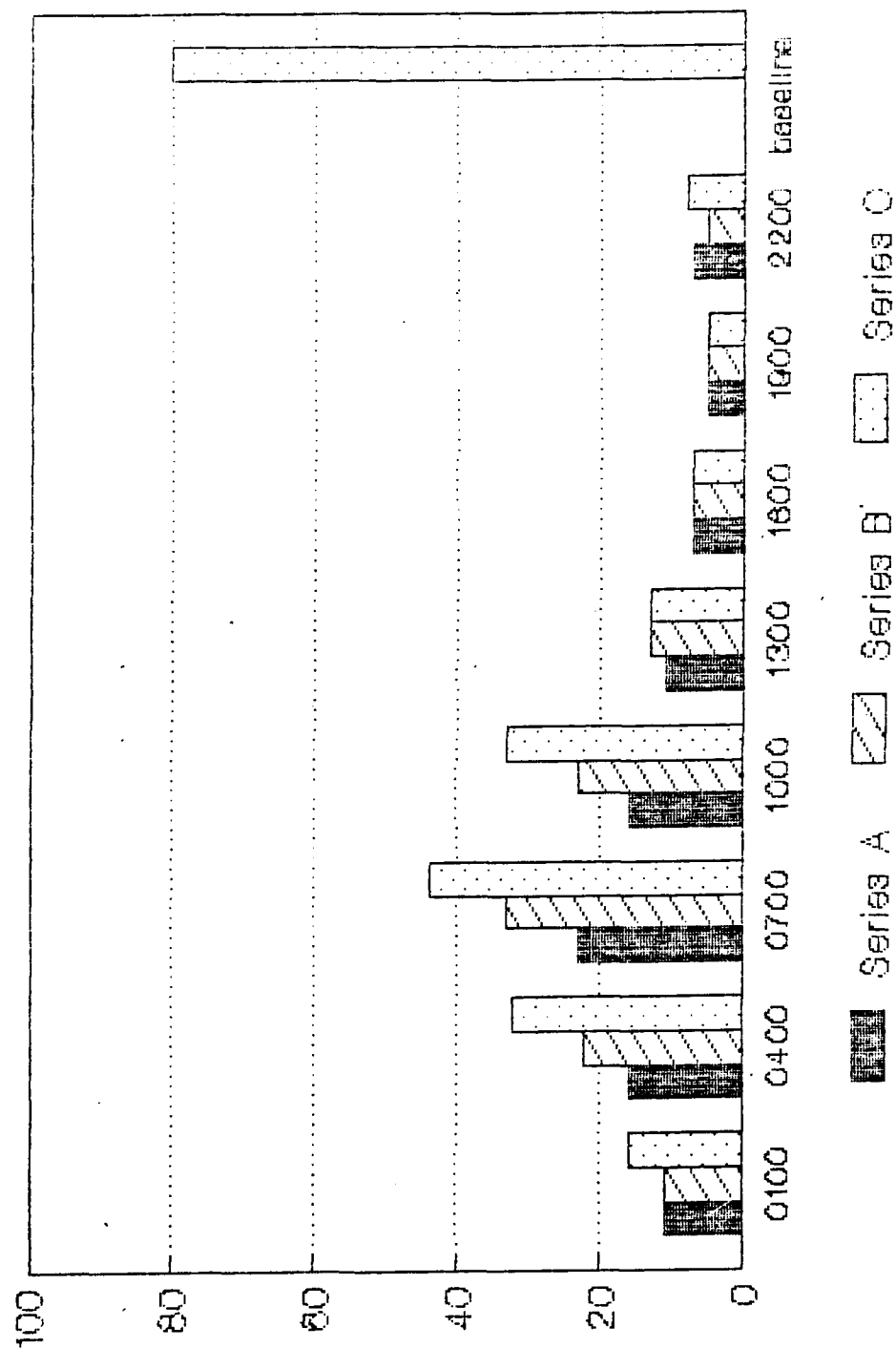
Ramstein AB, GE

Apr/May/Jun



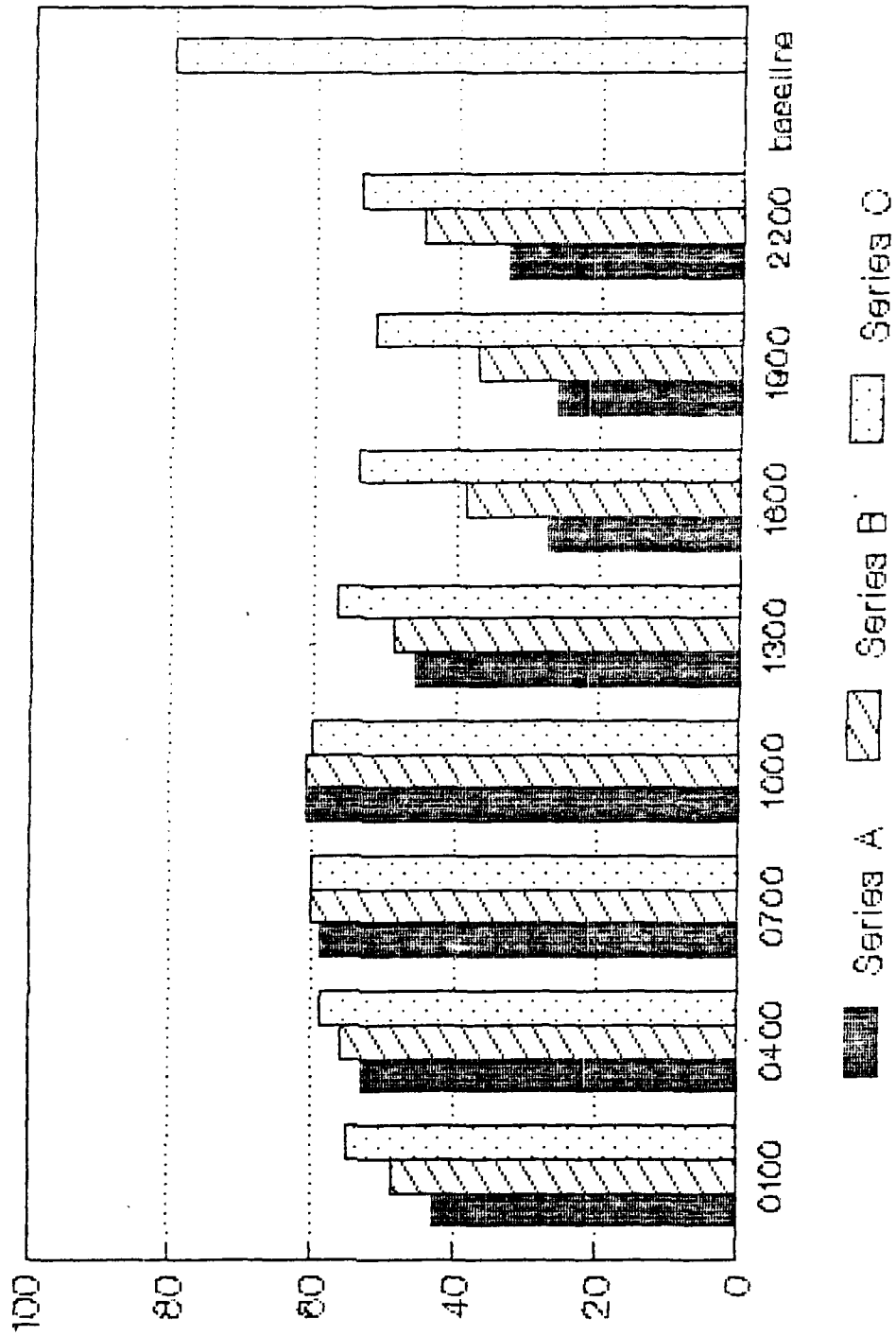
Ramstein AB, GE

Jul/Aug/Sep



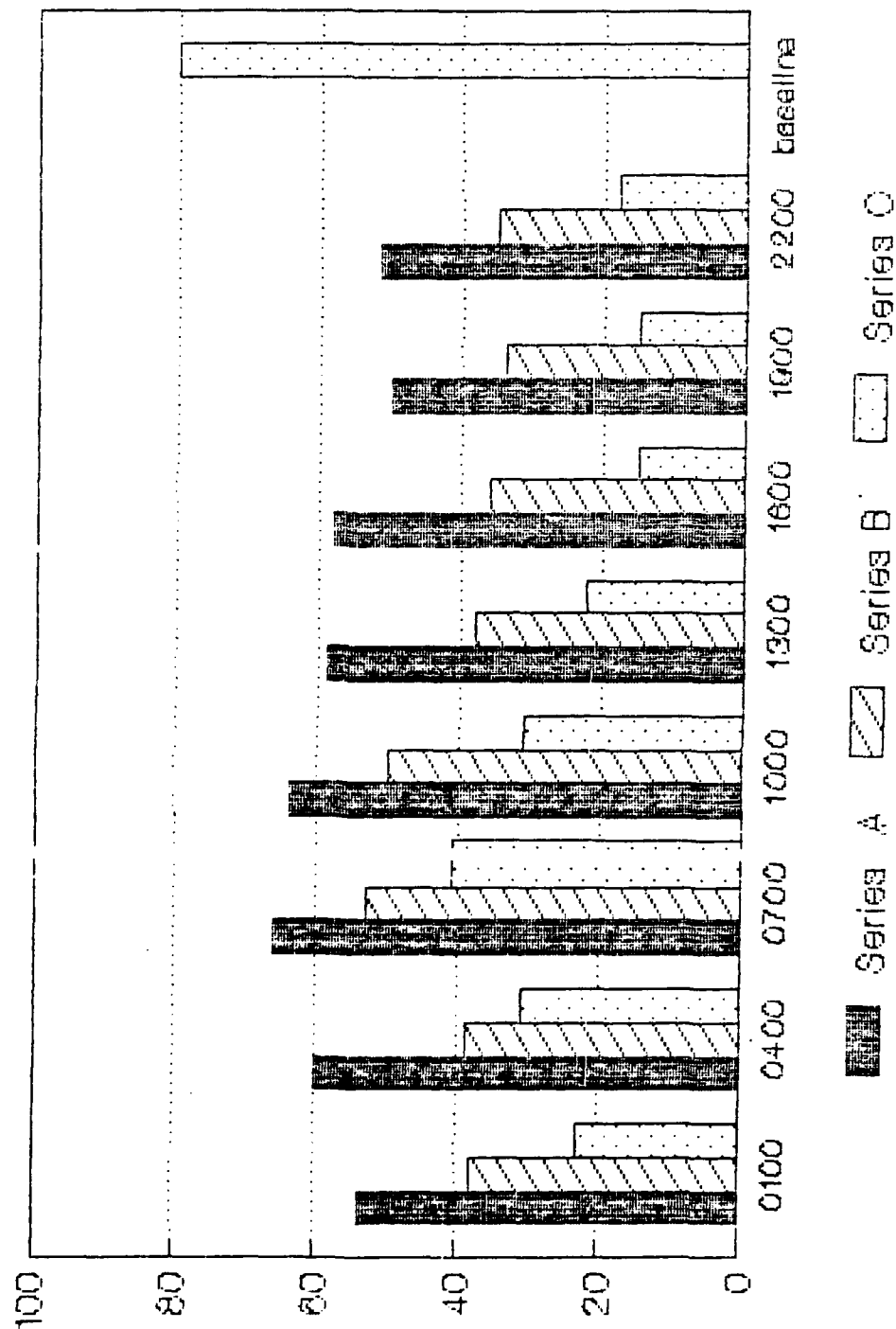
Ramstein AB, GE

Oct/Nov/Dec



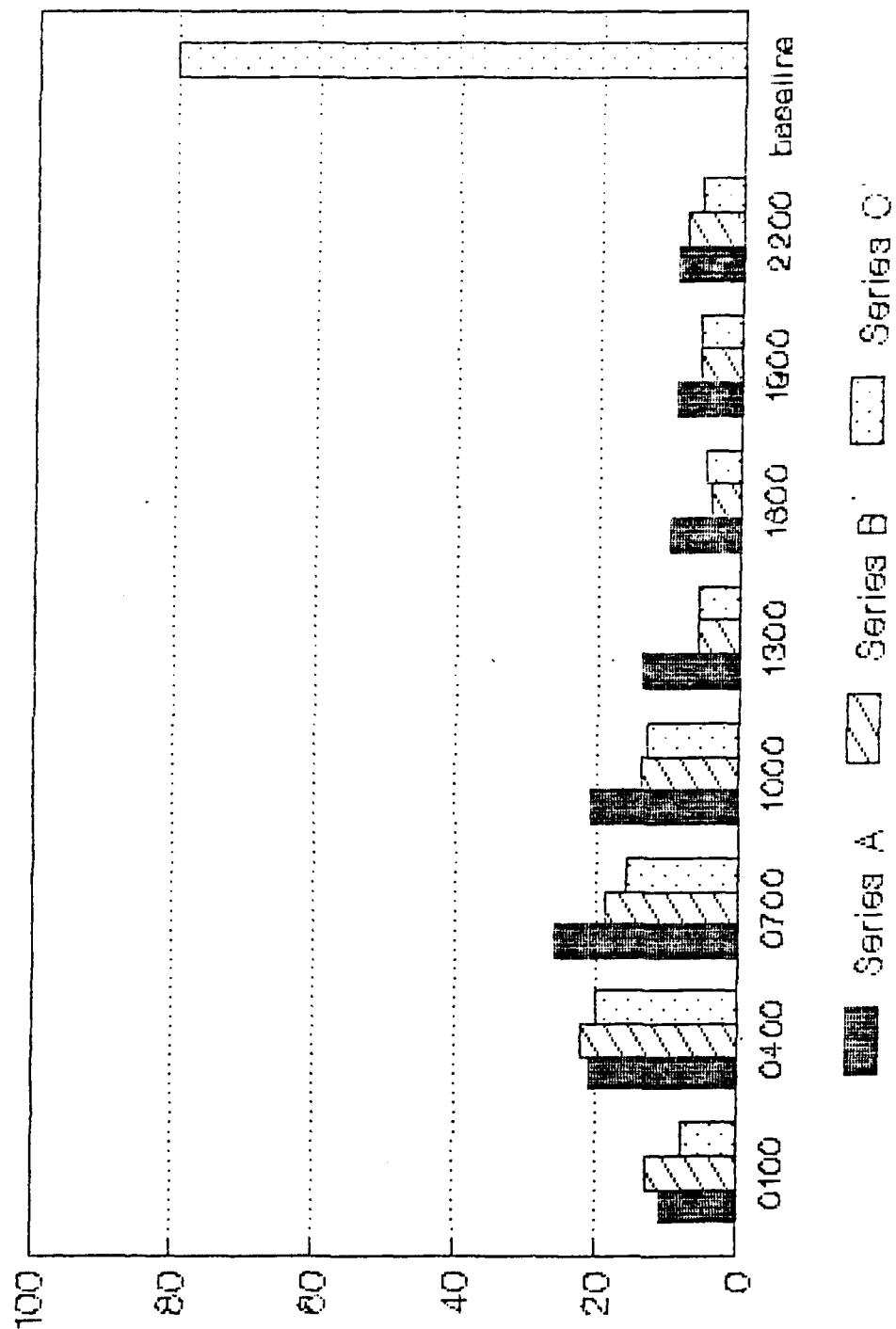
Rhein Main AB, GE

Jan/Feb/Mar



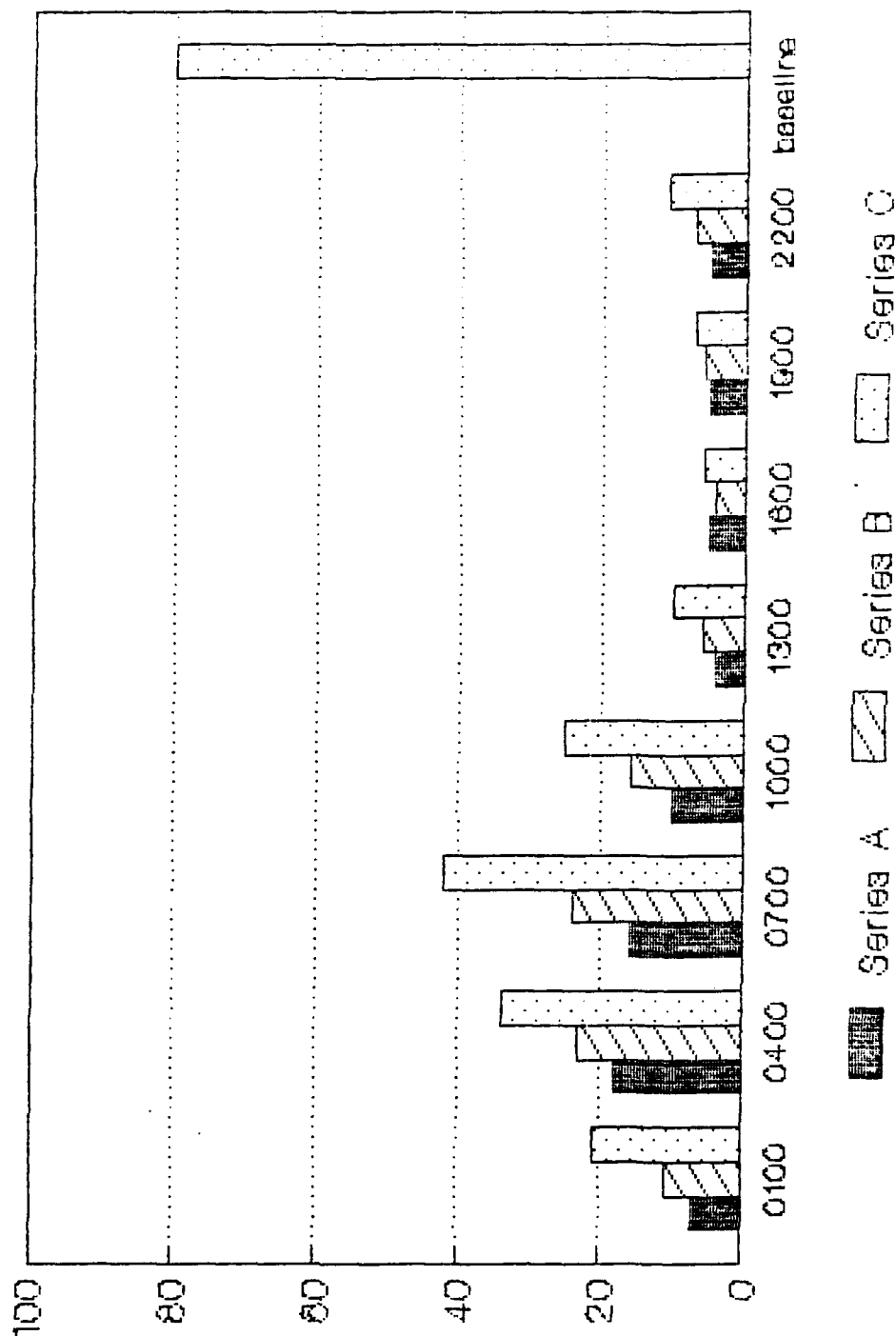
Rhein Main AB, GE

Apr/May/Jun



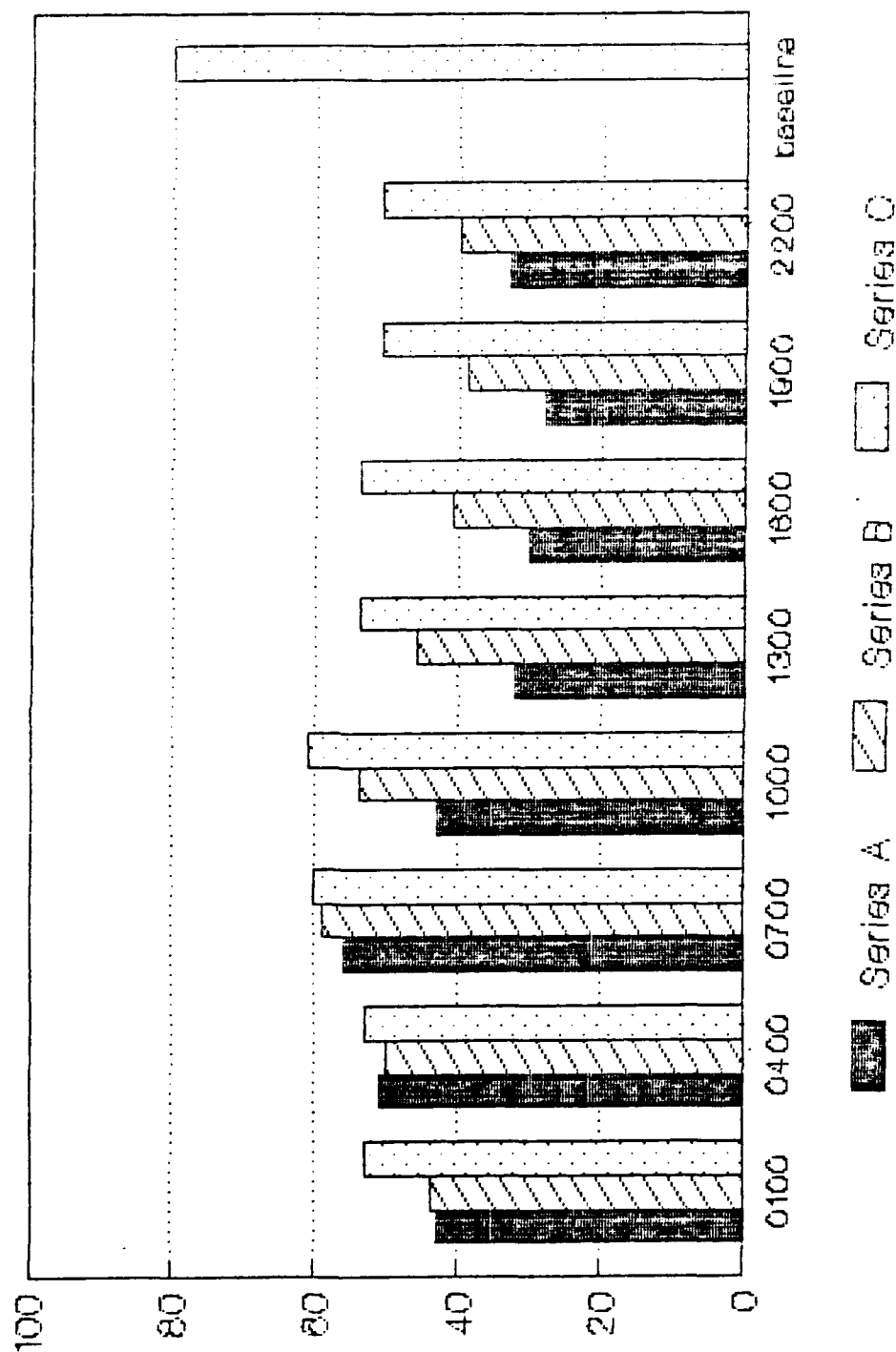
Rhein Main AB, GE

Jul/Aug/Sep



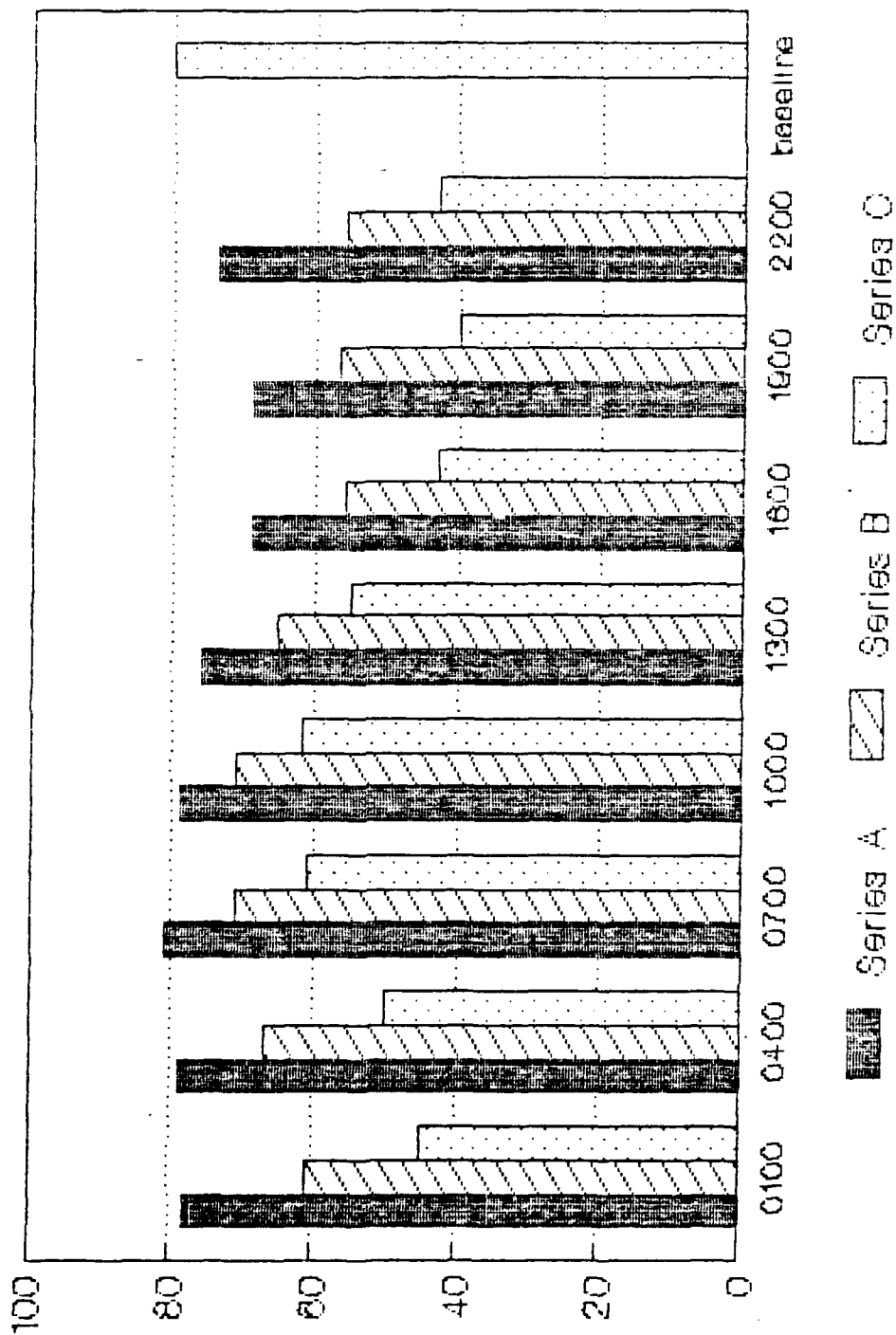
Rhein Main AB, GE

Oct/Nov/Dec



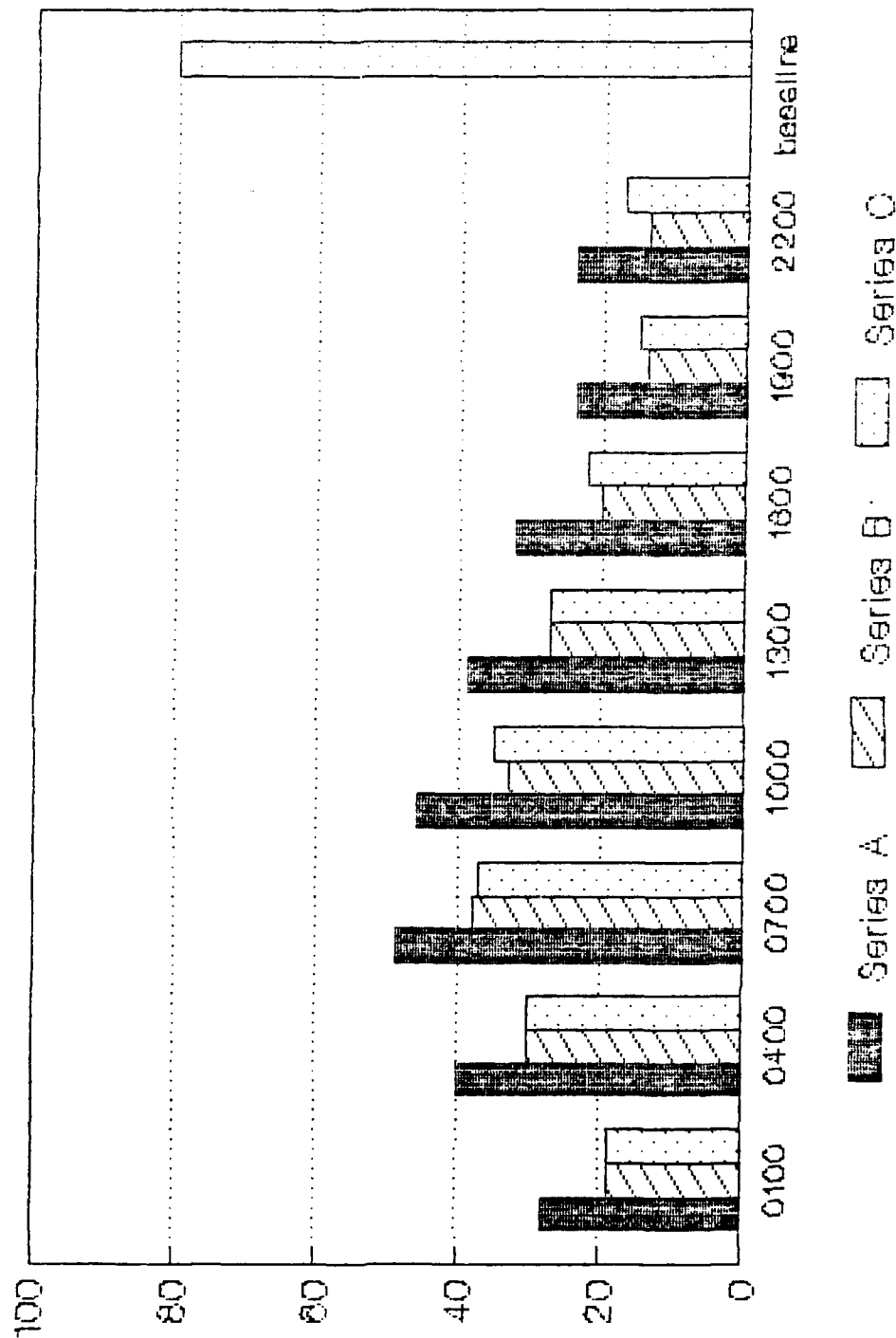
Hahn AB, GE

Jan/Feb/Mar



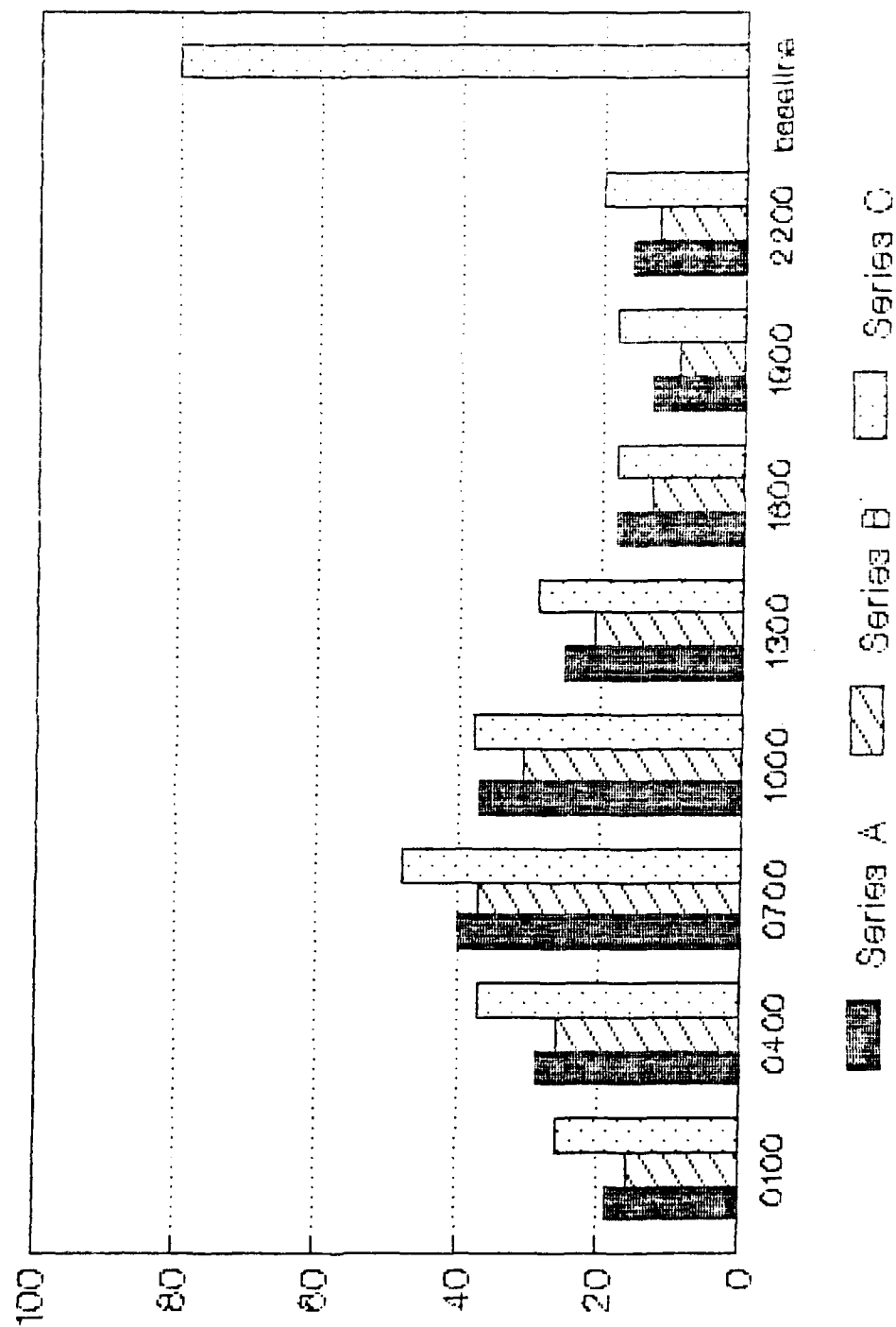
Hahn AB, GE

Apr/May/June



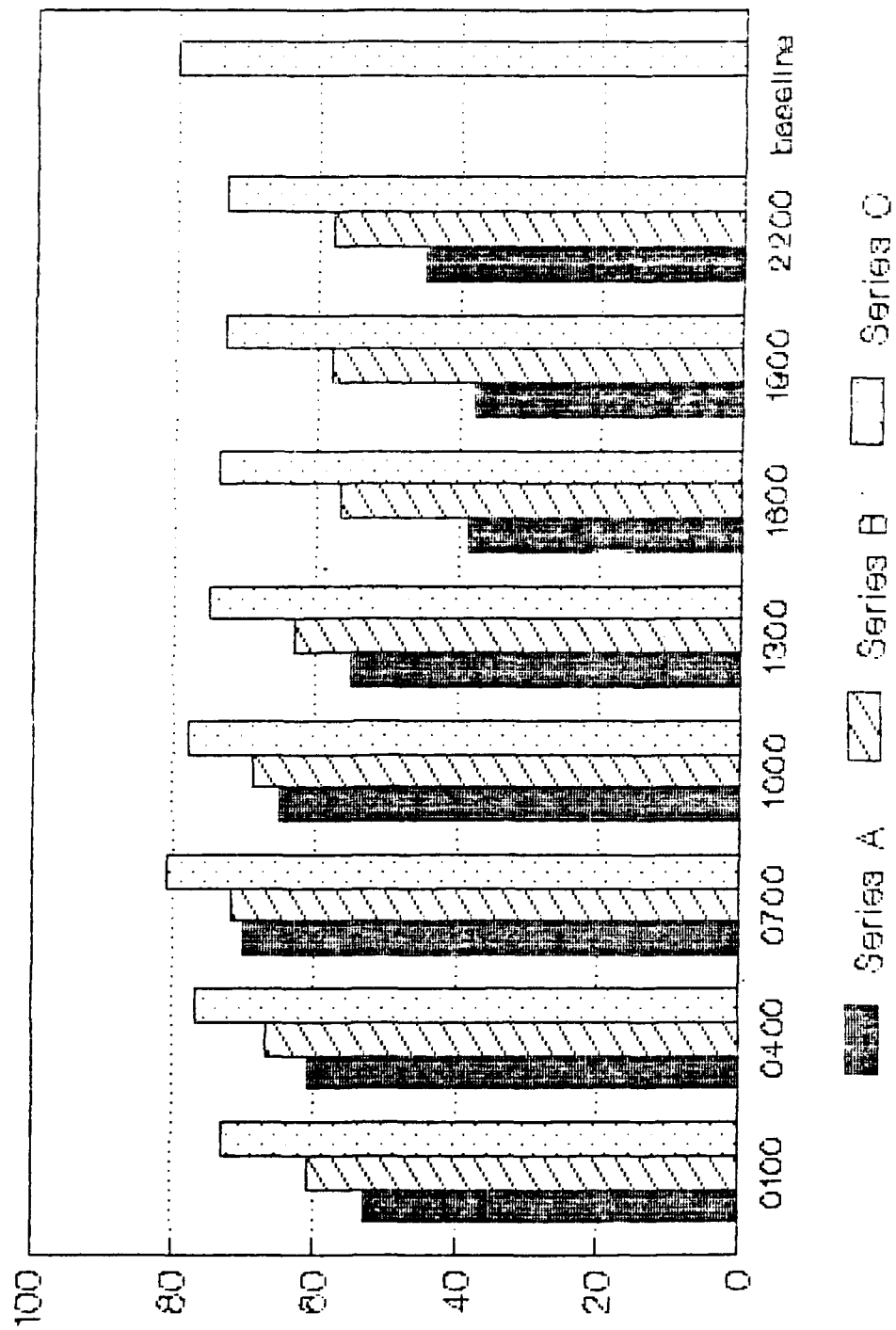
Hahn AB, GE

Jul/Aug/Sep



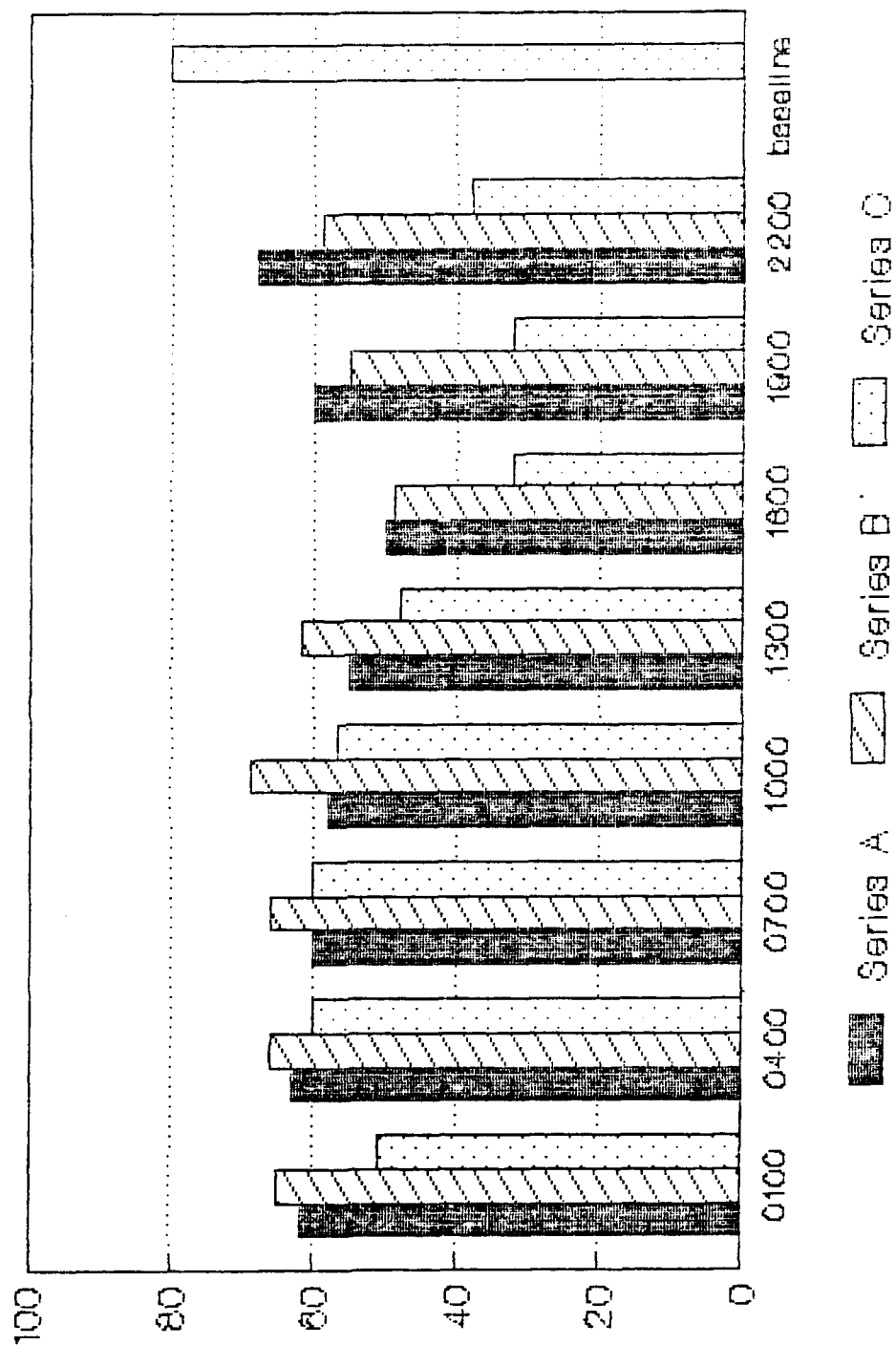
Hahn AB, GE

Oct/Nov/Dec



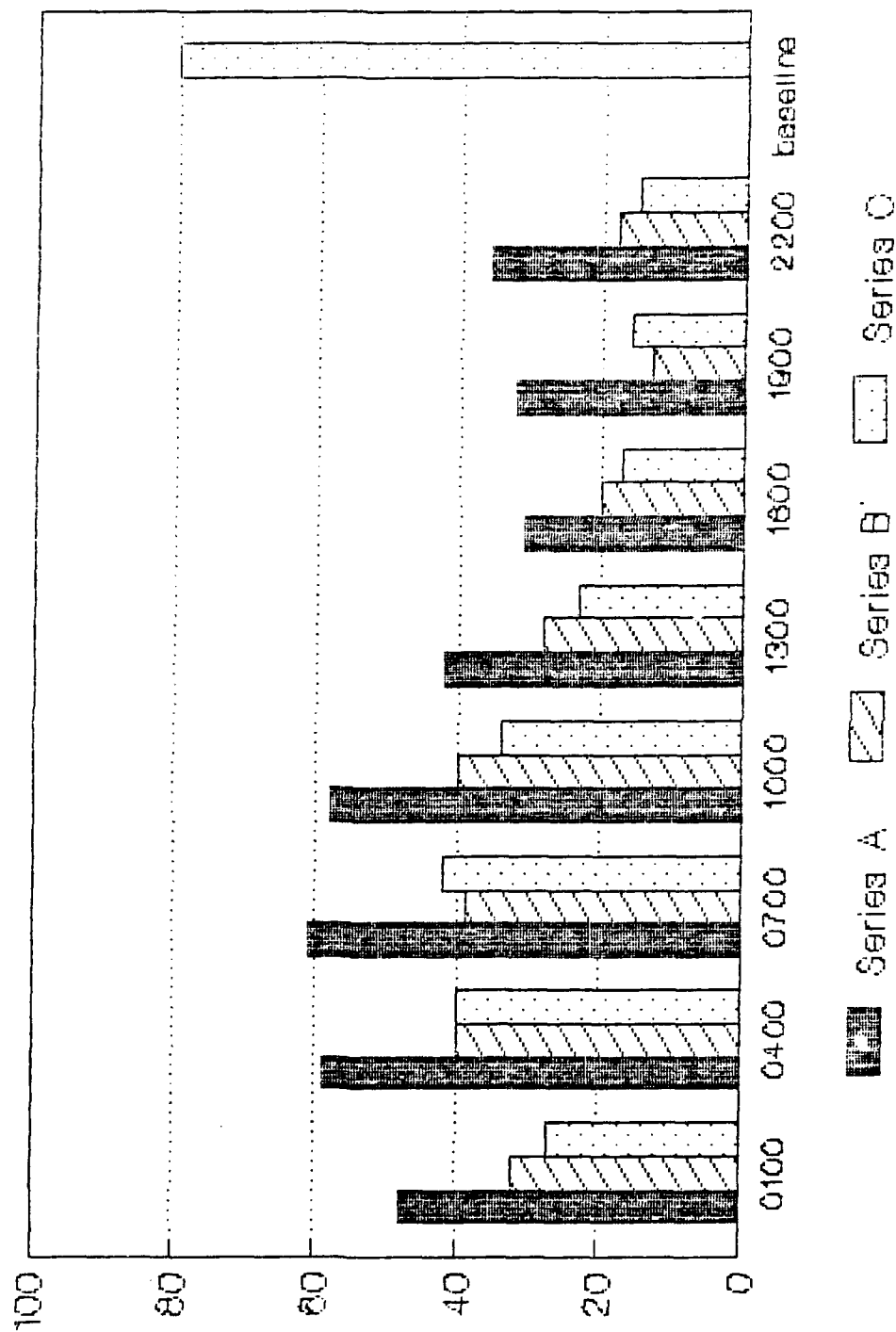
RAF Fairford, UK

Jan/Feb/Mar



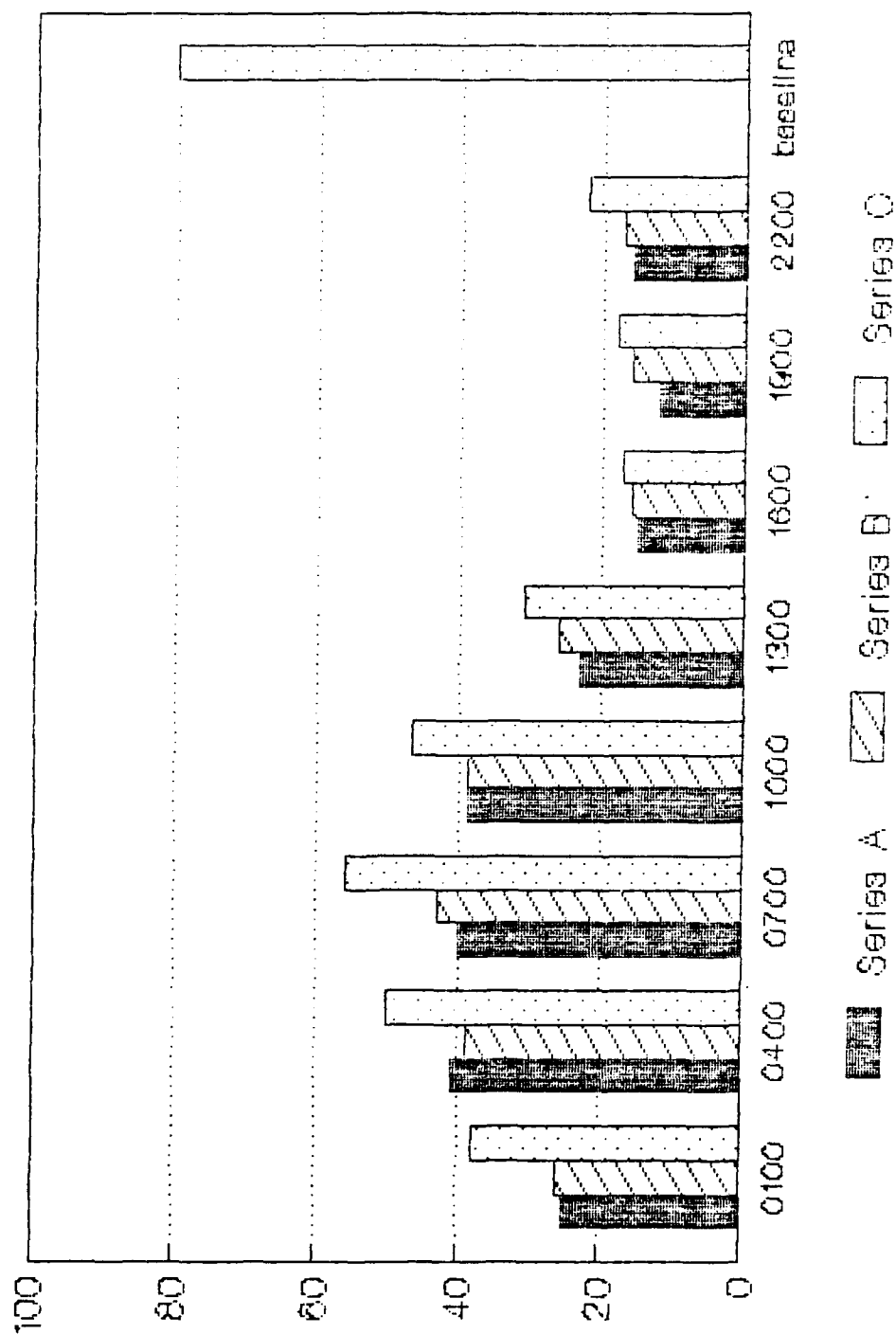
RAF Fairford, UK

Apr/May/Jun



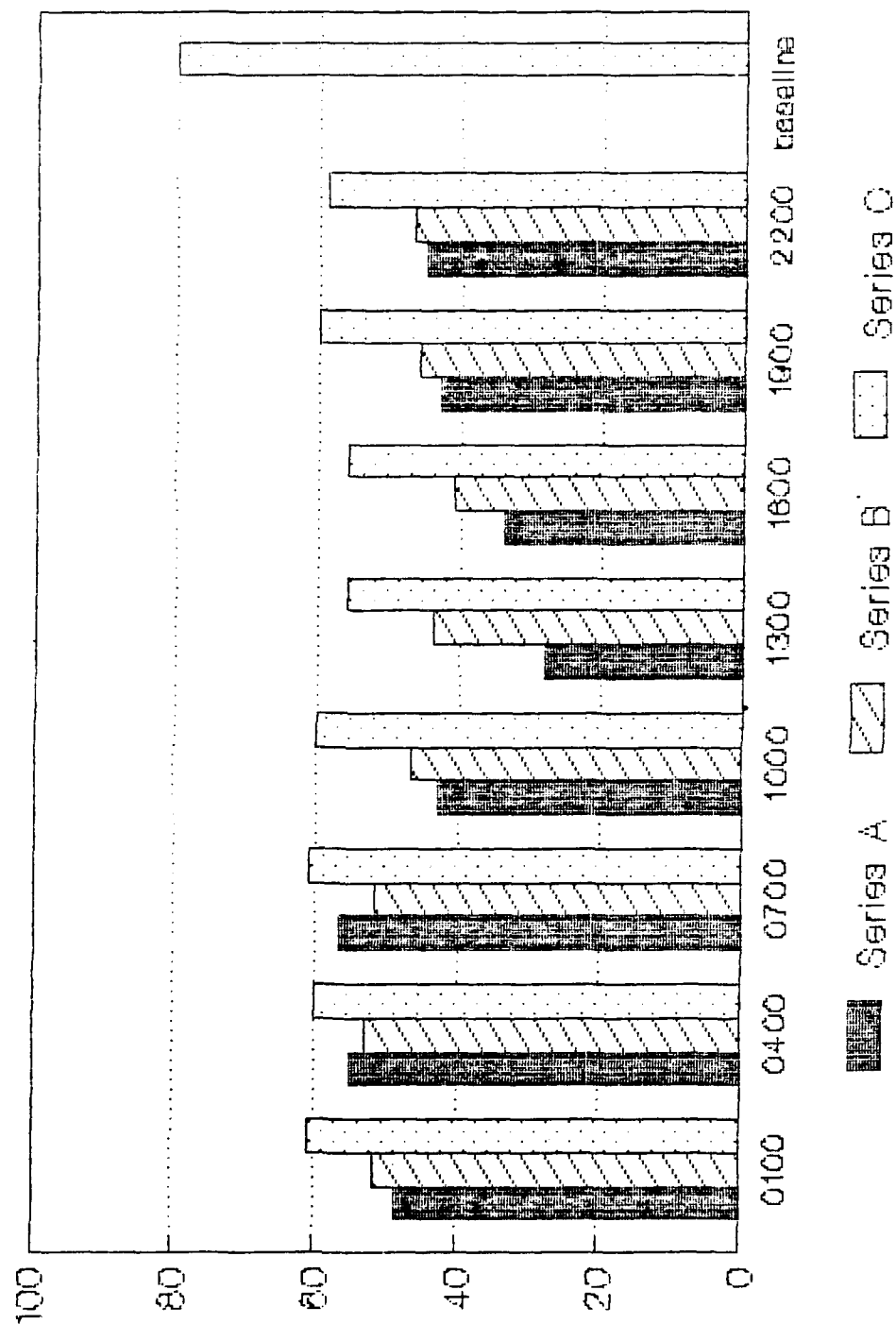
RAF Fairford, UK

Jul/Aug/Sep



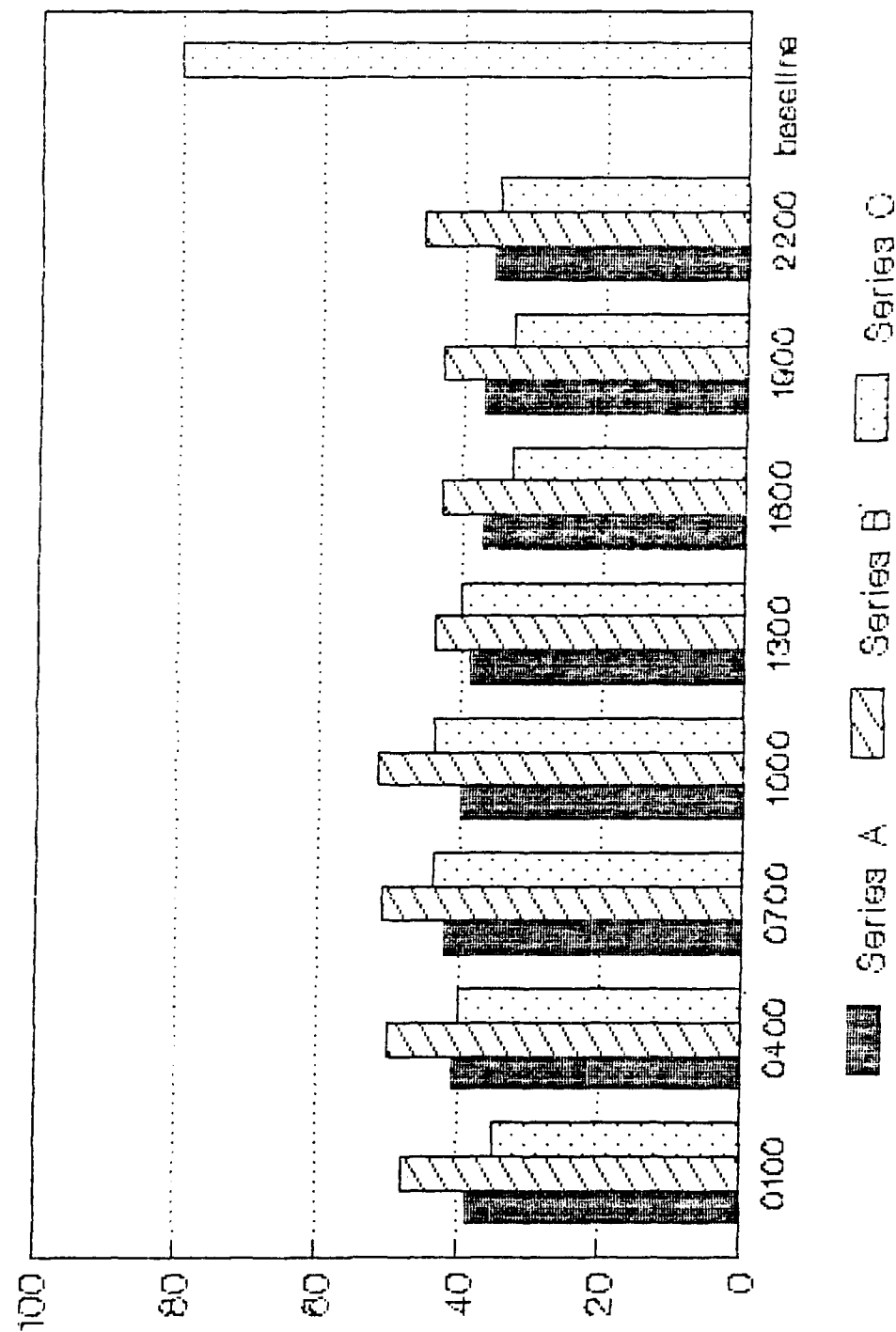
RAF Fairford, UK

Oct/Nov/Dec



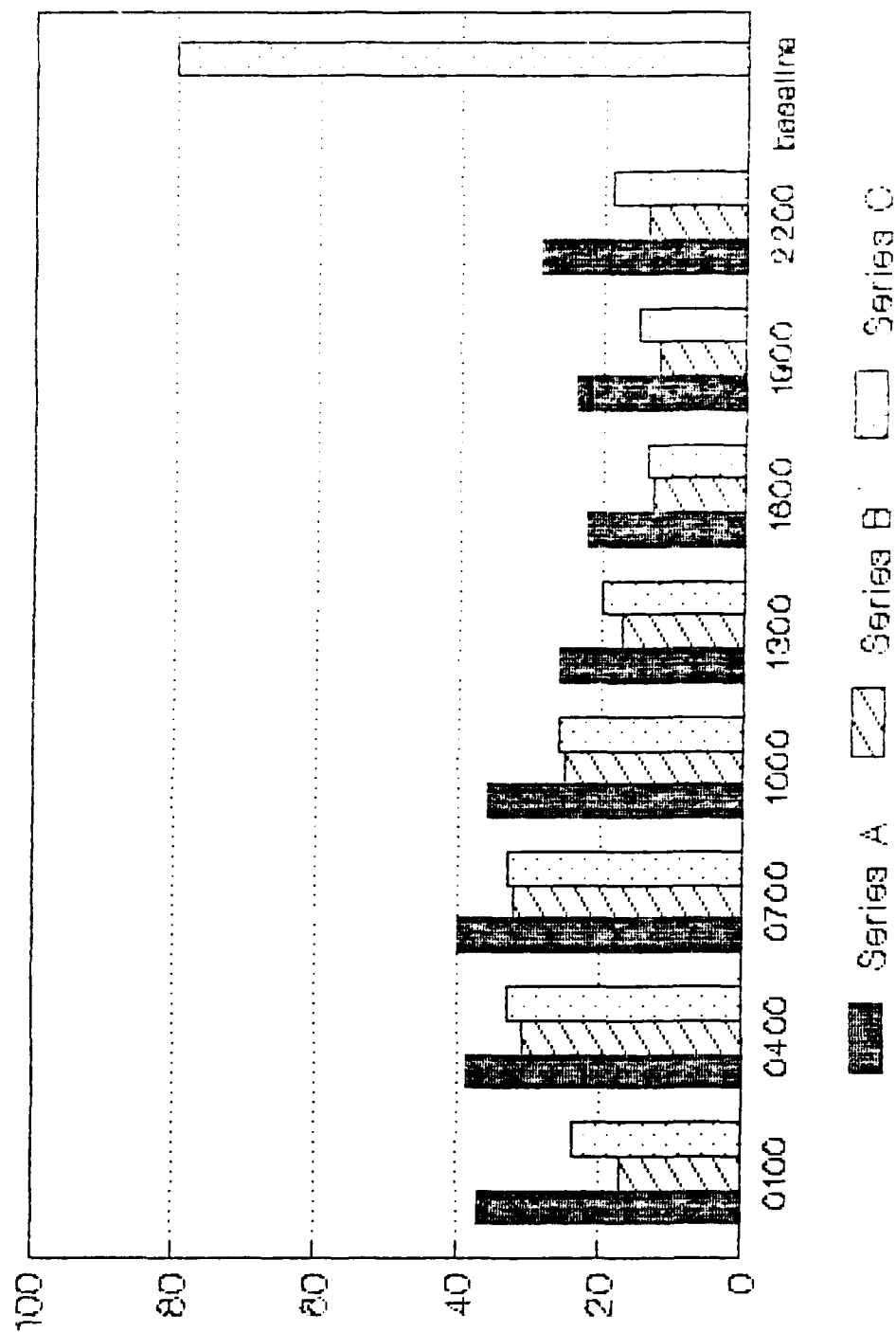
RAF Bentwaters, UK

Jan/Feb/Mar



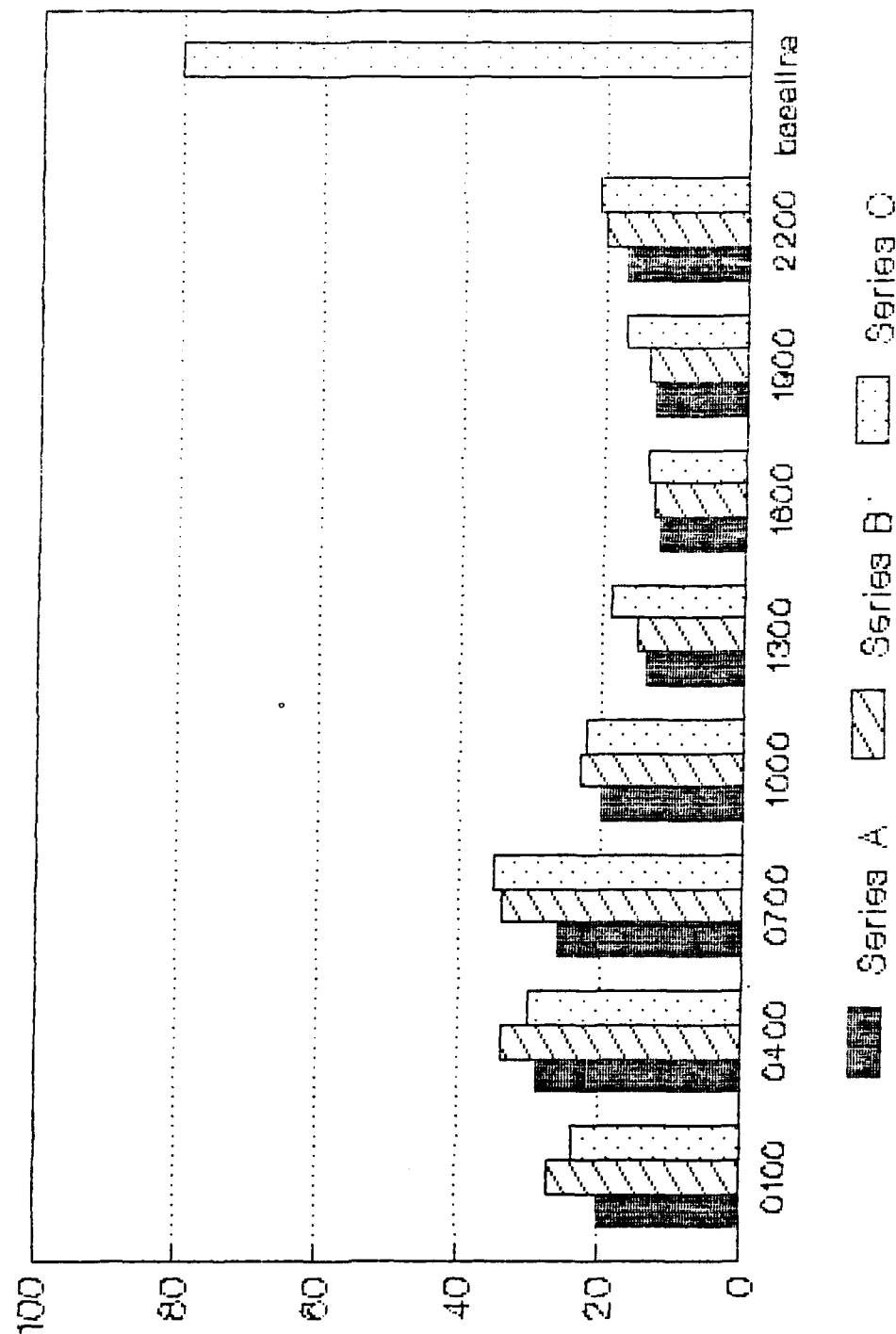
RAF Bentwaters, UK

Apr/May/June



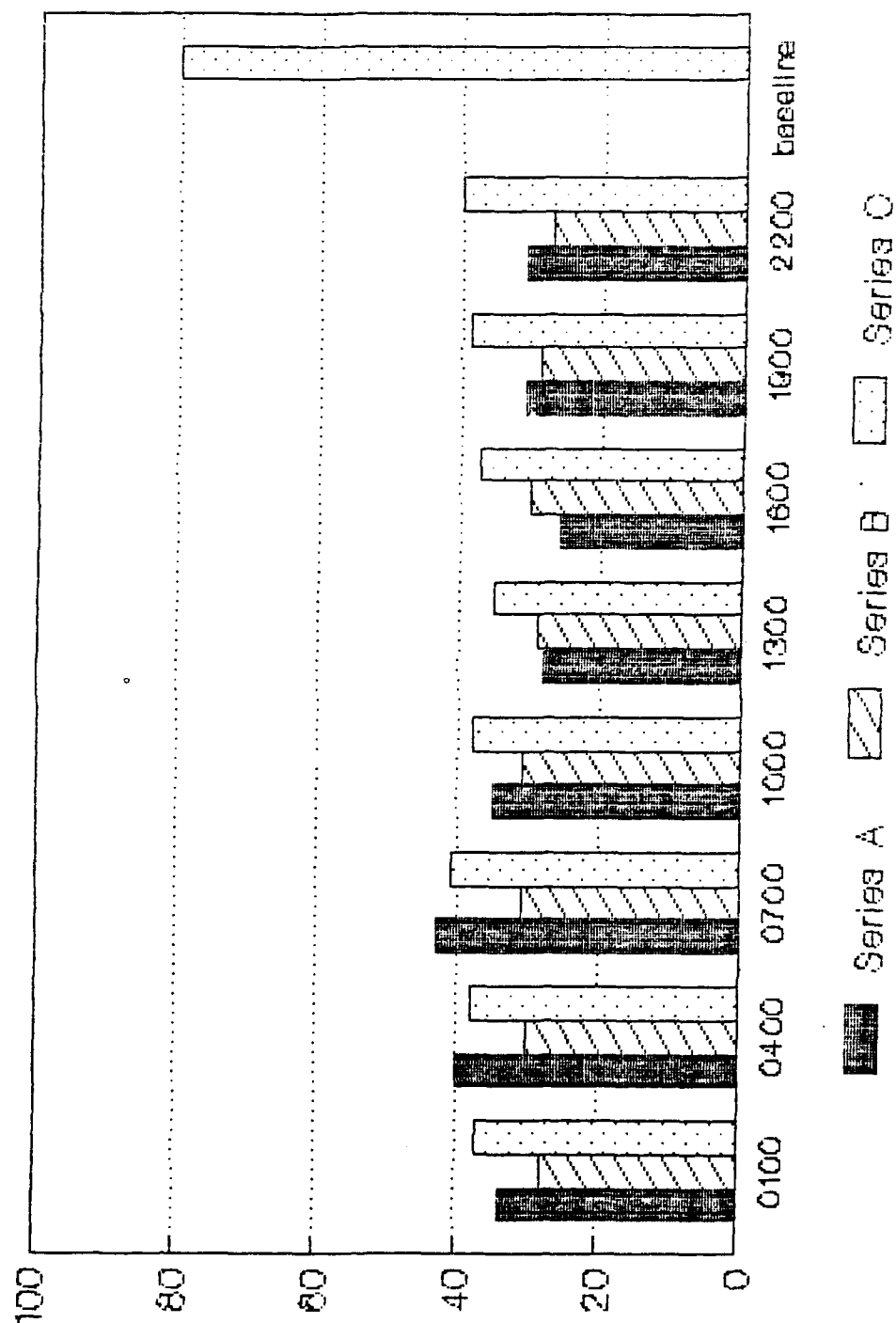
RAF Bentwaters, UK

Jul/Aug/Sep



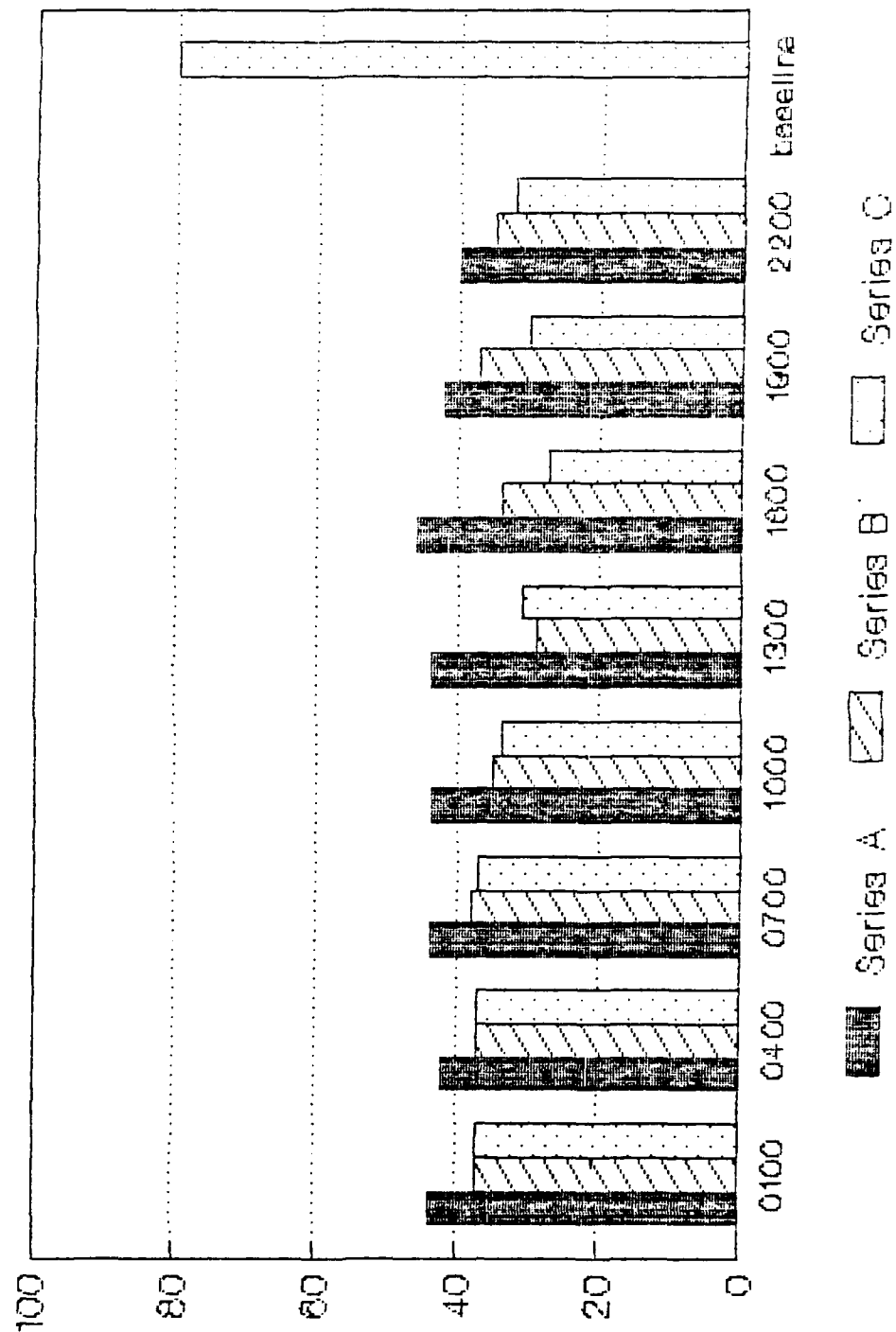
RAF Bentwaters, UK

Oct/Nov/Dec



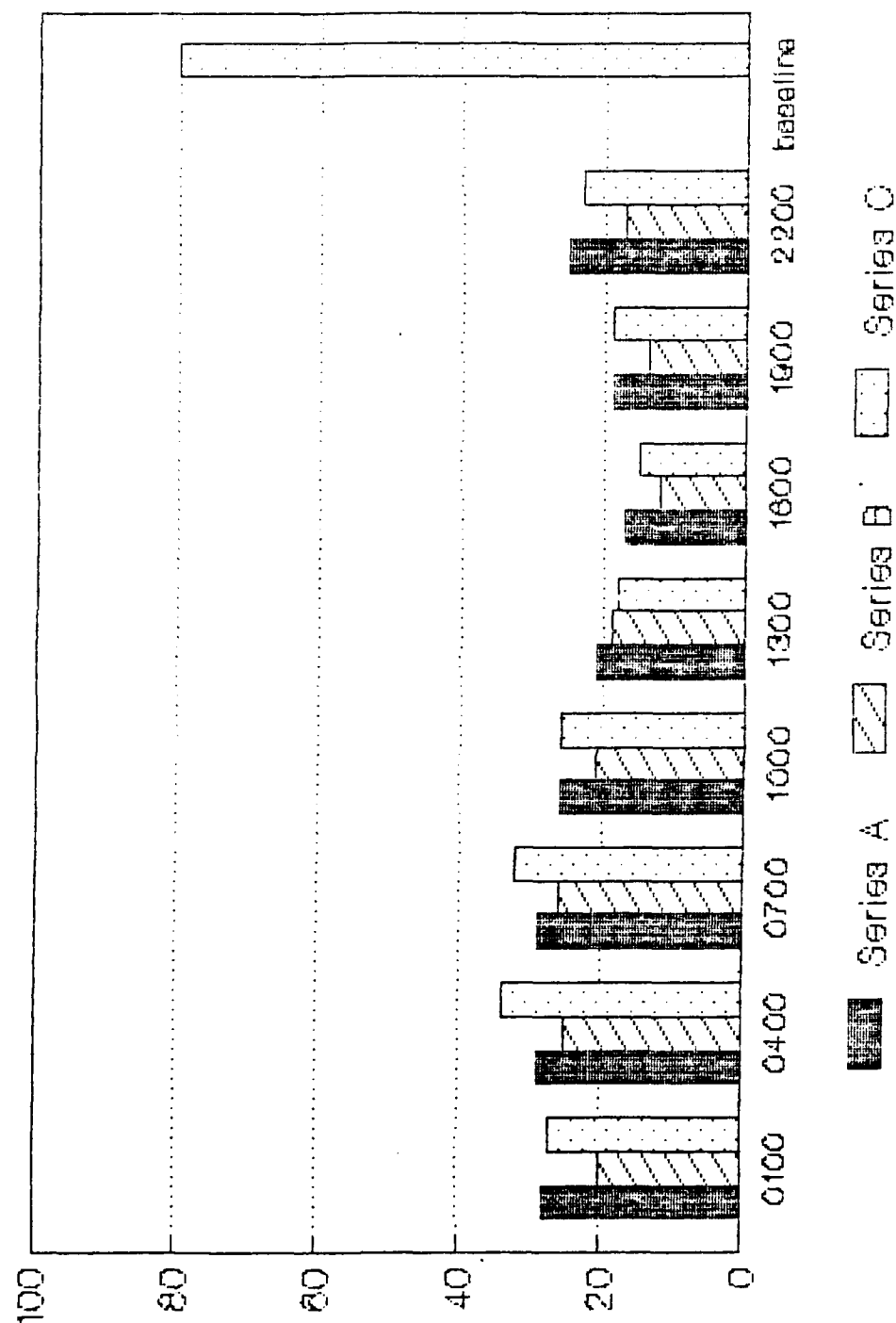
Prestwick, Scotland

Jan/Feb/Mar



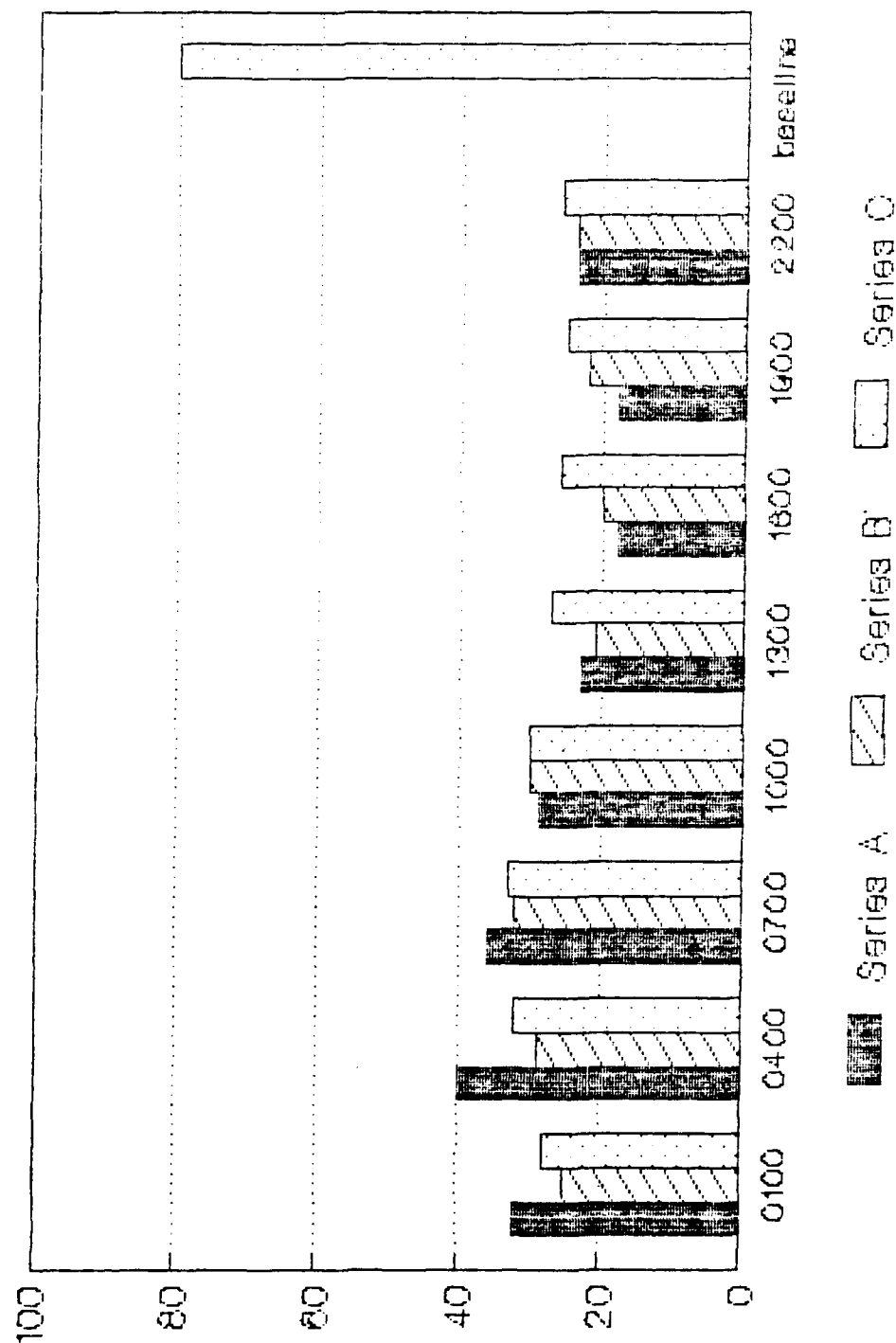
Prestwick, Scotland

Apr/May/Jun



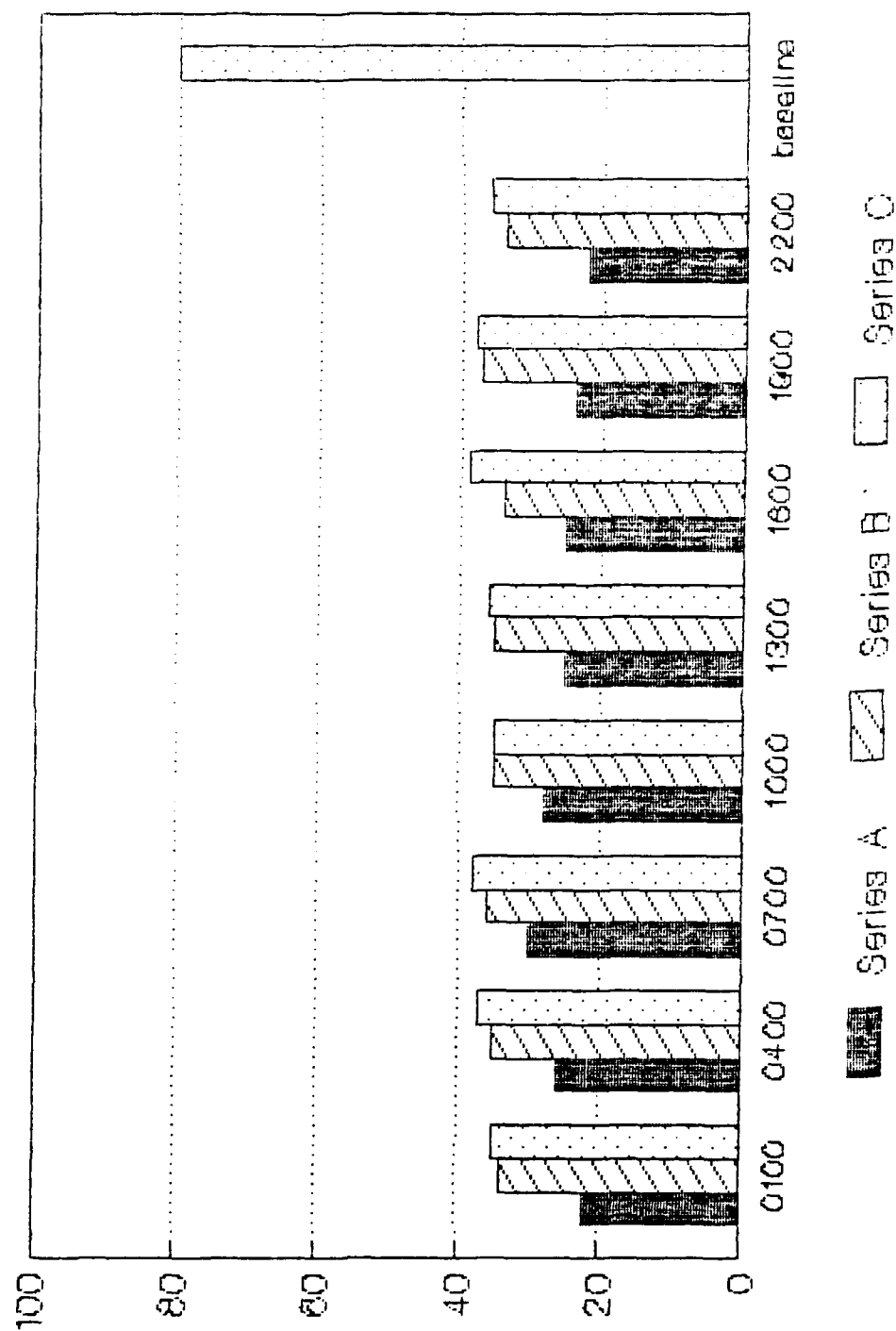
Prestwick, Scotland

Jul/Aug/Sep



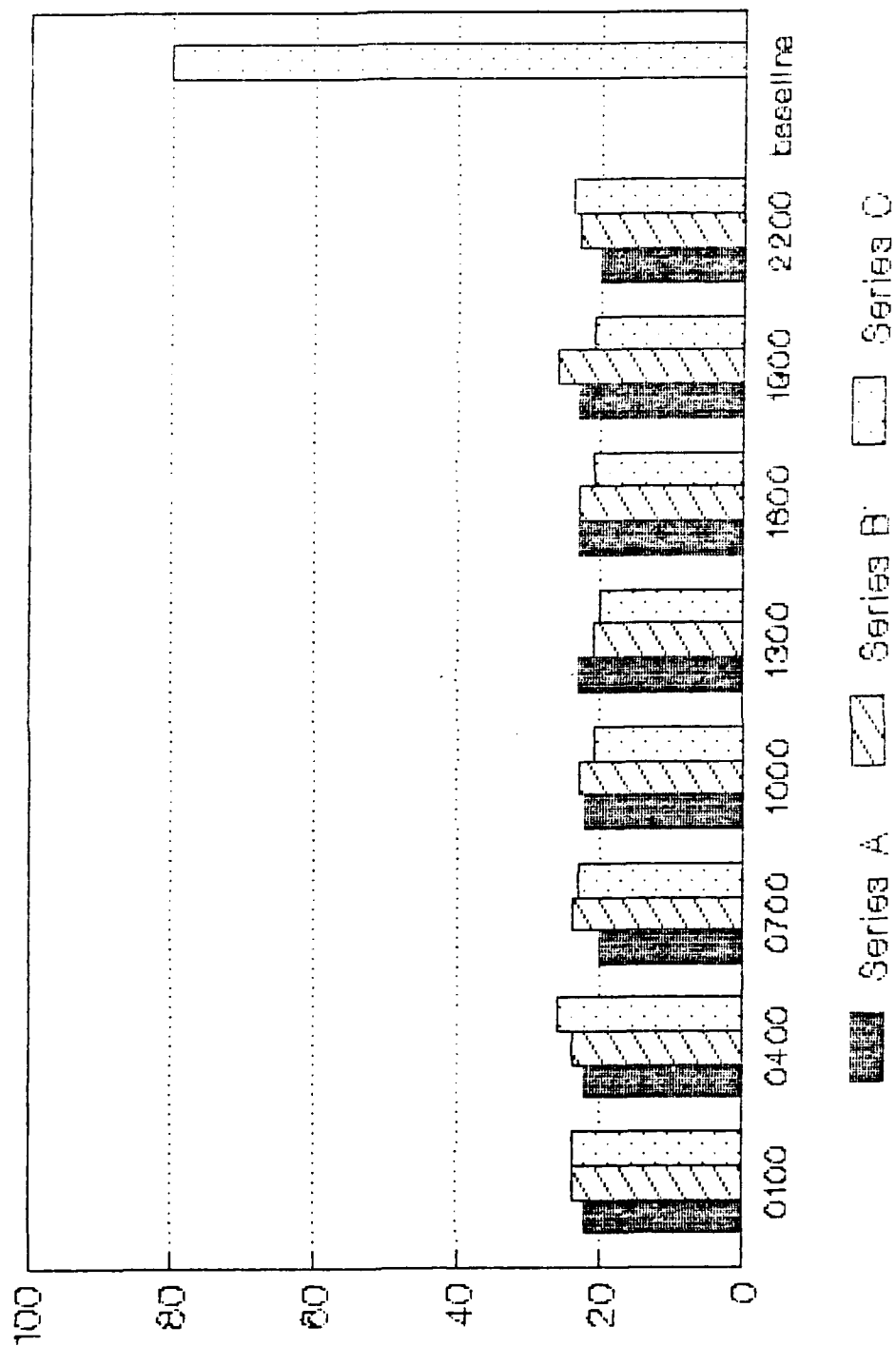
Prestwick, Scotland

Oct/Nov/Dec



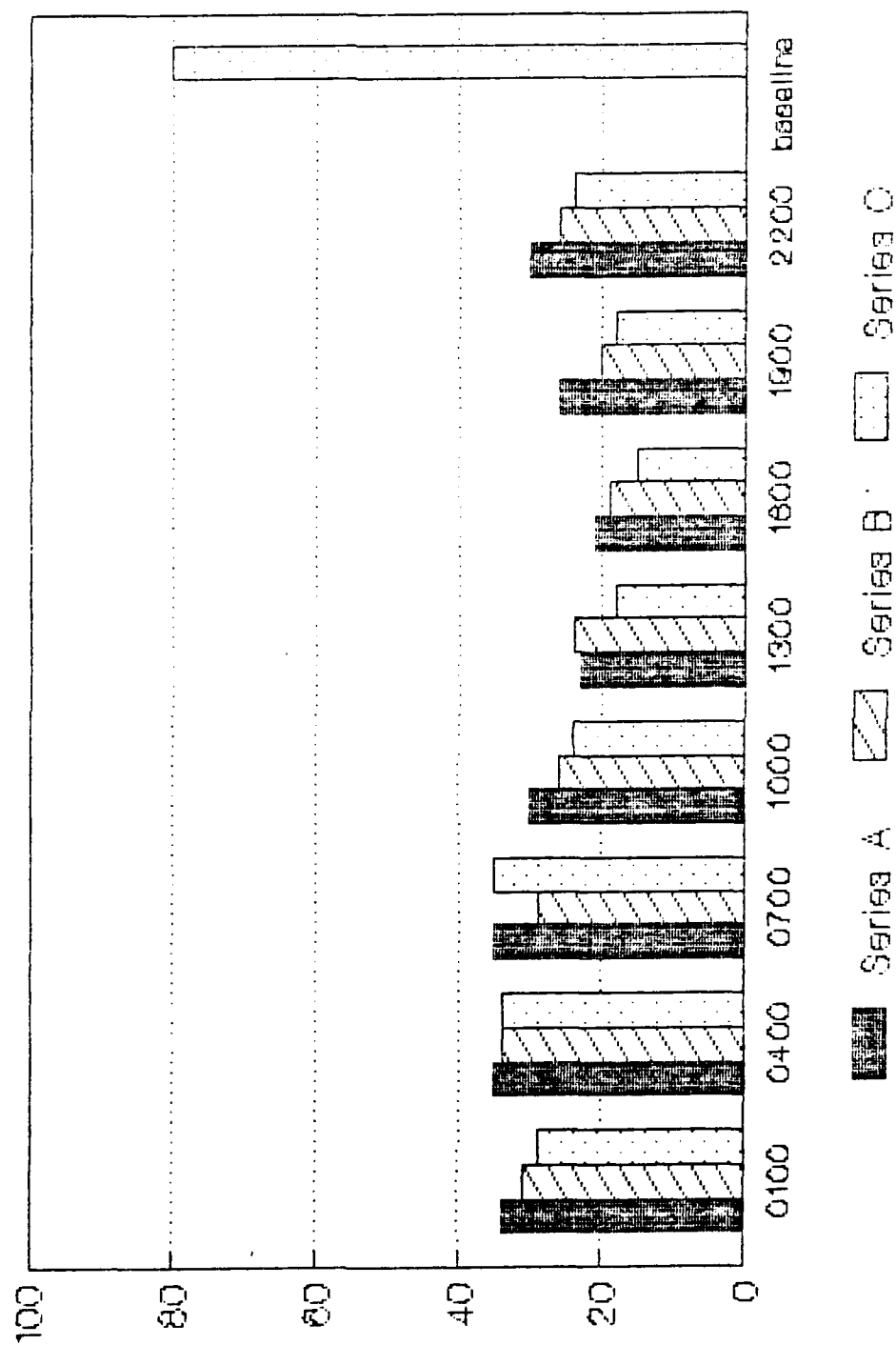
Lossiemouth, Scotland

Jan/Feb/Mar



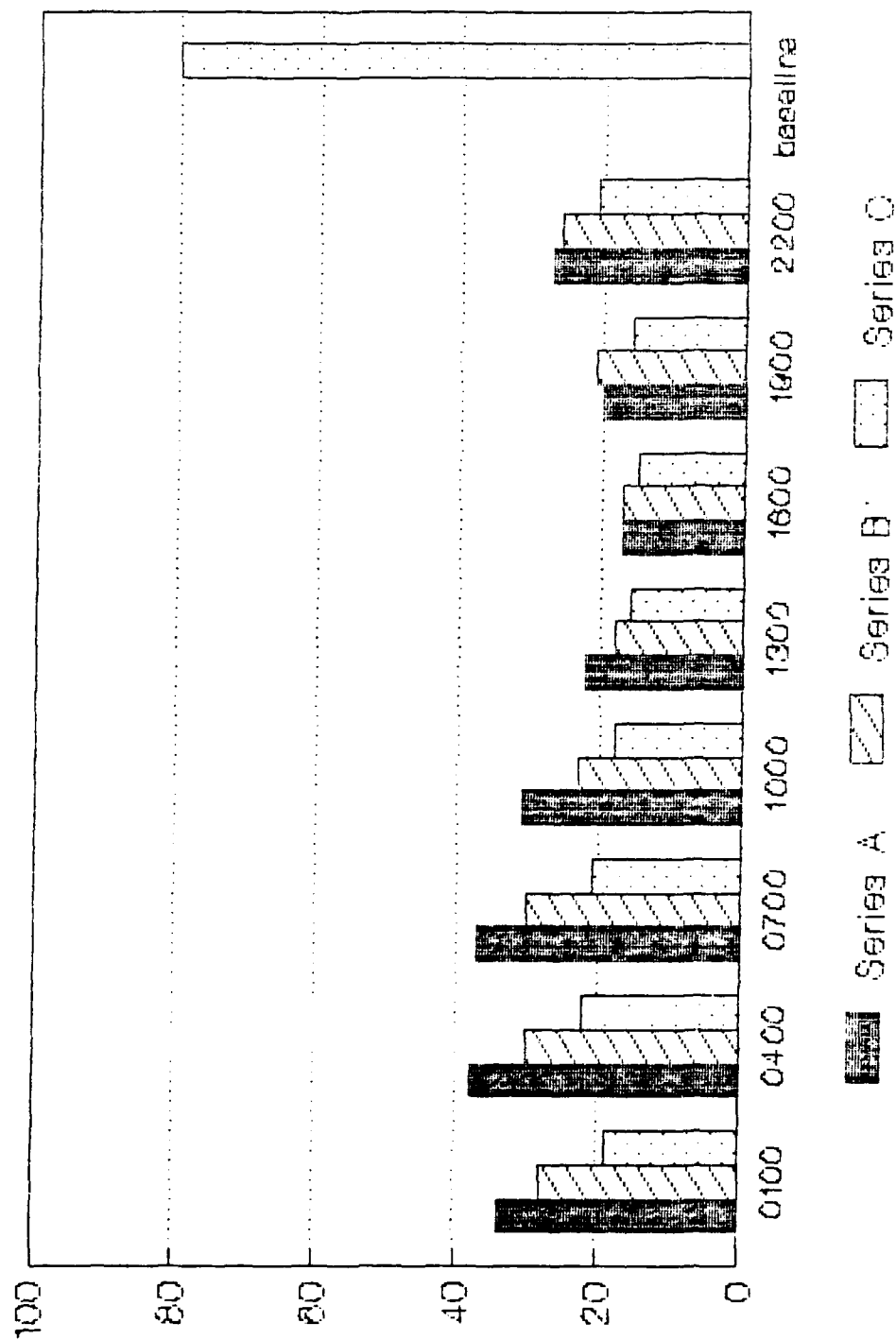
Lossiemouth, Scotland

Apr/May/Jun



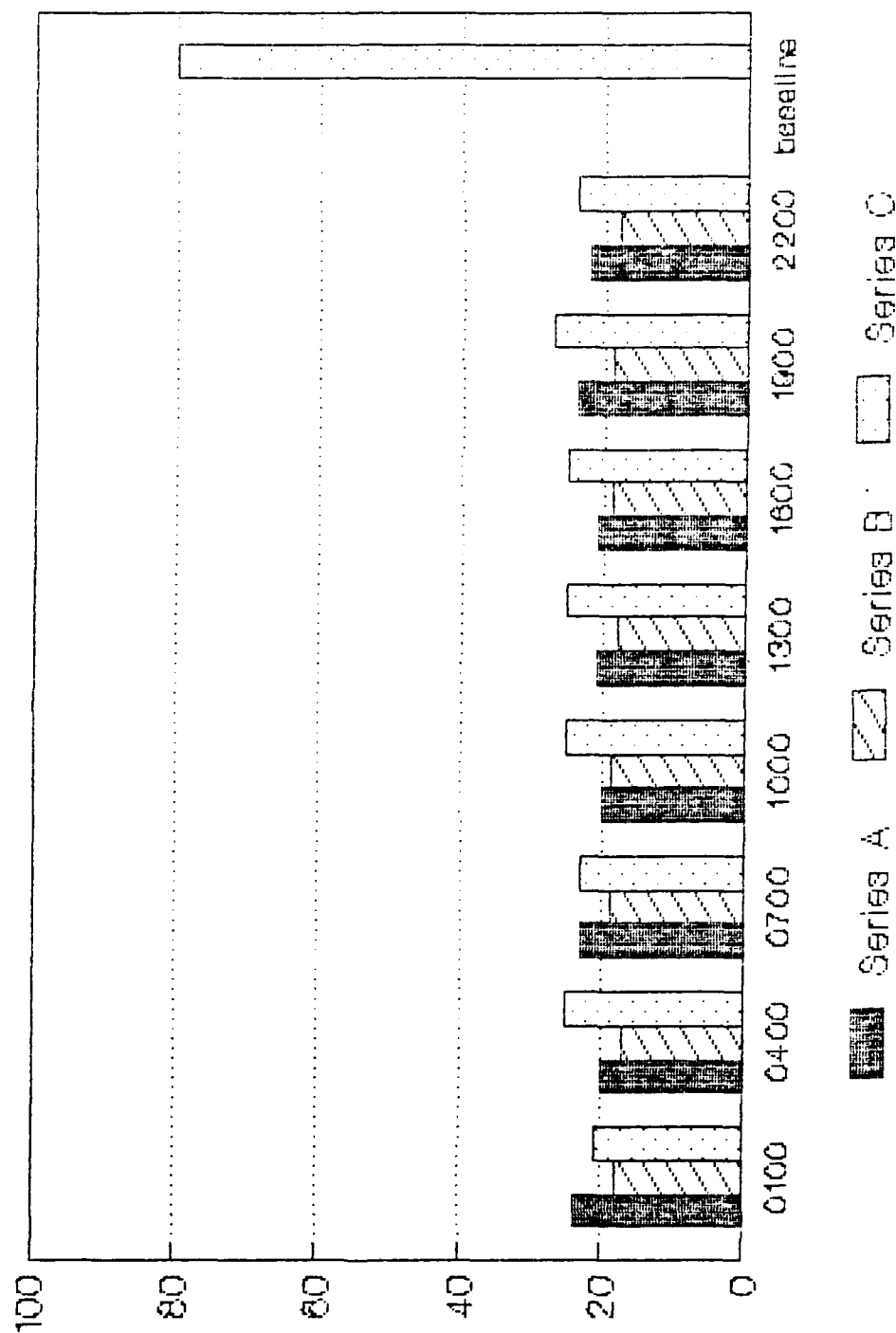
Lossiemouth, Scotland

Jul/Aug/Sep



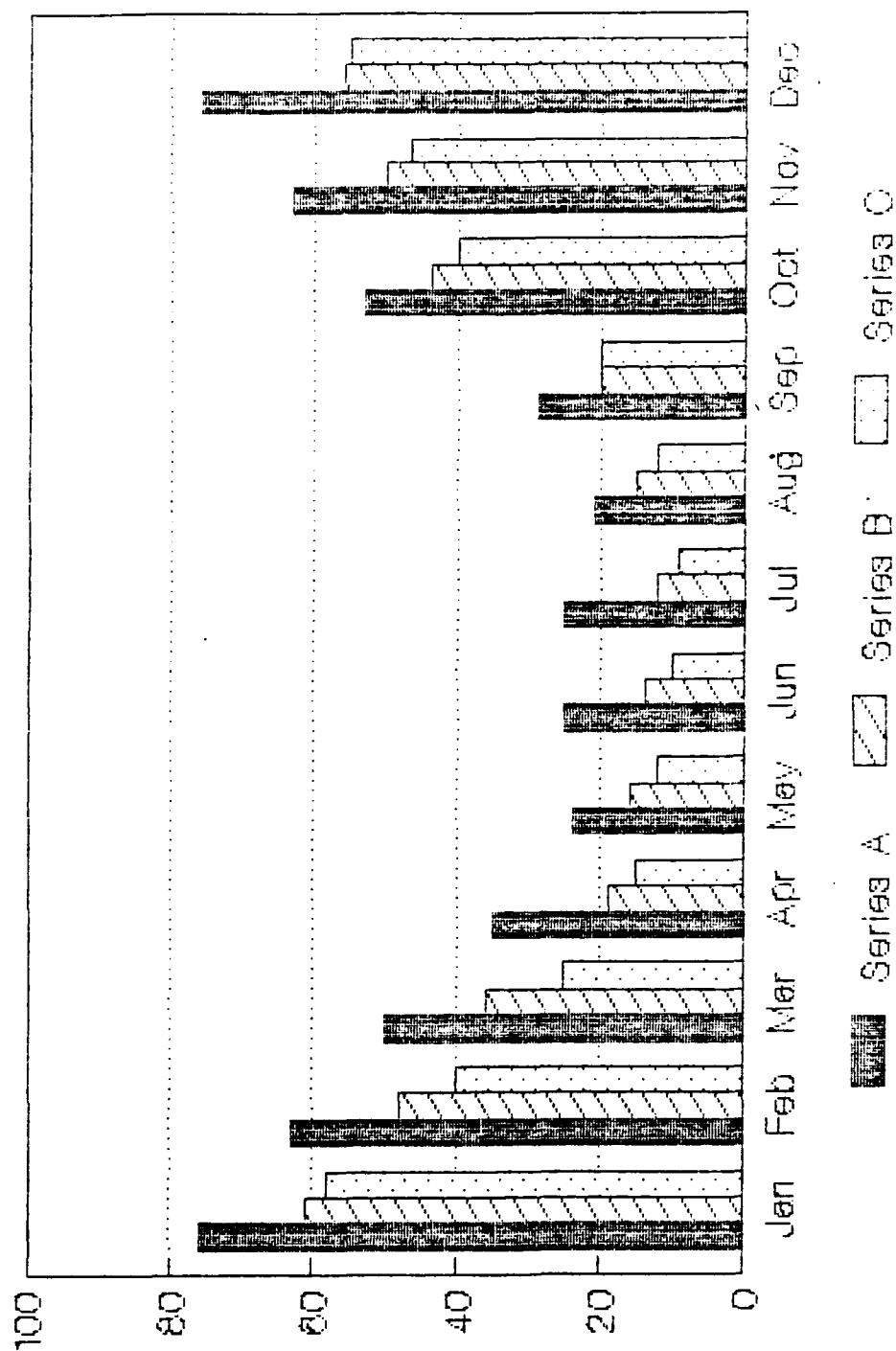
Lossiemouth, Scotland

Oct/Nov/Dec



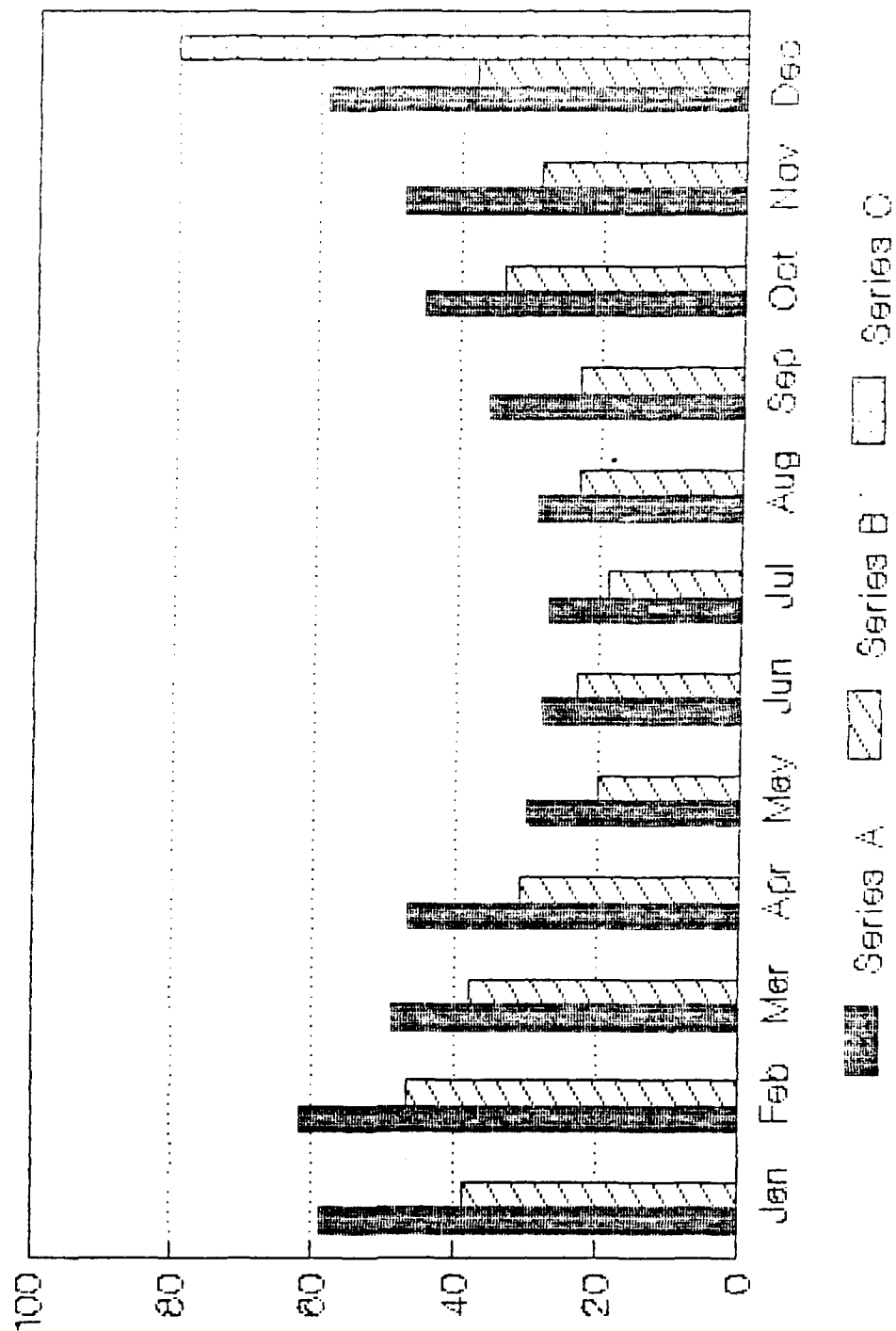
Germany

Monthly Averages



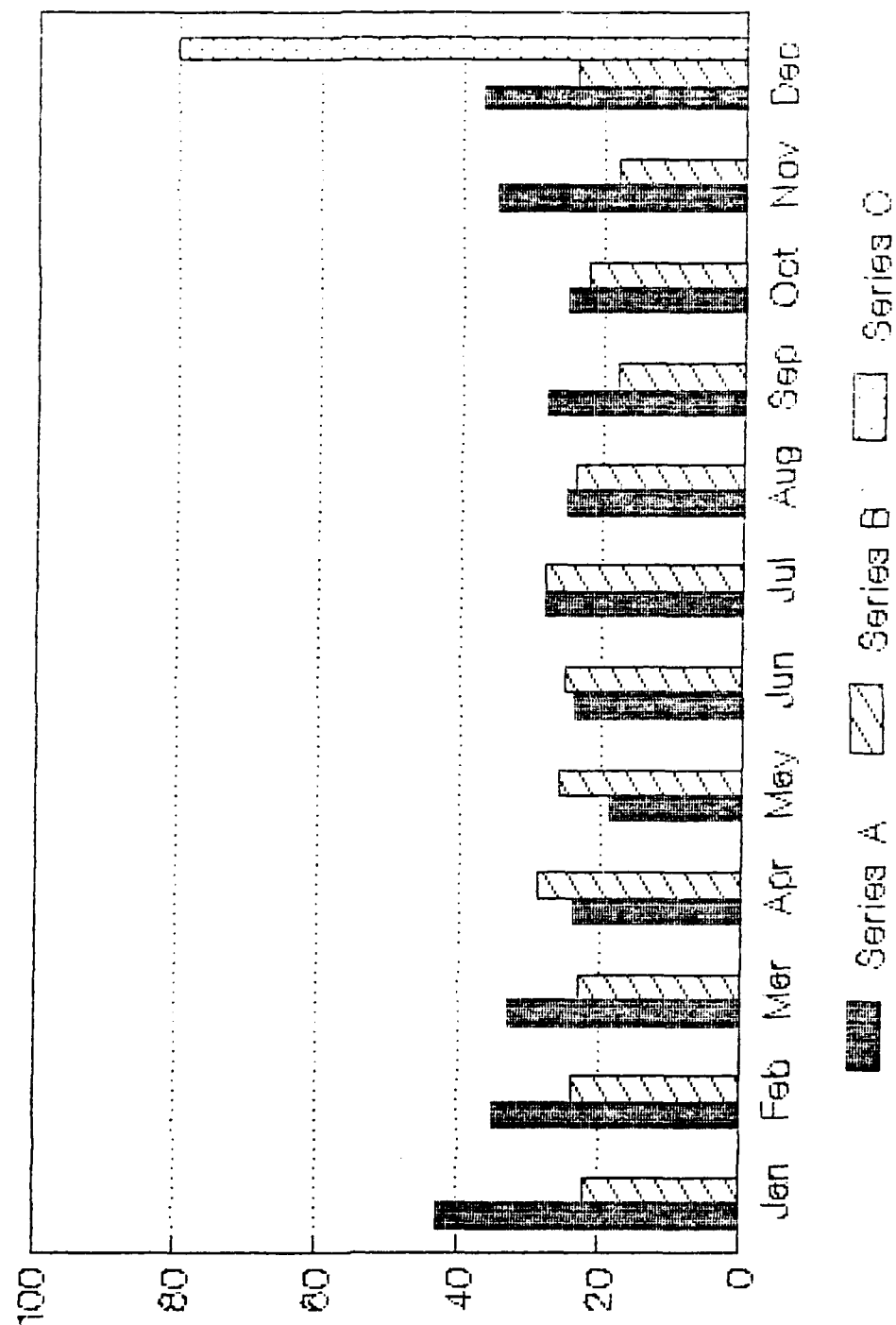
United Kingdom

Monthly Averages



Scotland

Monthly Averages



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